# OPERATING AND MAINTENANCE MANUAL

**MODEL 8531**
**POWER METER**

WAVETEK MICROWAVE, INC.

8531

## WAVETEK MICROWAVE THANKS YOU FOR YOUR CONFIDENCE IN OUR EQUIPMENT

## AND

In order to serve you and your requirements better, Wavetek Microwave would deeply appreciate your help and a few minutes of your time to answer the questions listed on this card. As with our instruments, we are constantly striving to provide our customers with publications and instructional material that will serve your needs in the best possible manner. By receiving inputs from you and our other customers, our publications can be structured to provide you with complete information in the most usable and understandable format.

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☐ With the Instrument ☐ Other _____

_____

Who is the most frequent user? ☐ Engineer ☐ Technician

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# OPERATING AND MAINTENANCE MANUAL

5-31-88
S/N 1645
# 391

## MODEL 8531 POWER METER

SERIAL NUMBER 1645

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# TABLE OF CONTENTS

Page Number

SECTION 1 GENERAL INFORMATION

1.1 Wavetek Microwave, Inc. (WMI) Model 8531 Power Meter ..... 1-1

1.2 Specifications

1.2.1 Instrument Specifications ... ..... 1-1
1.2.2 Power Sensor Specifications ..... 1-4

1.3 Options ..... 1-4

1.4 Accessories

1.4.1 Supplied Accessories ..... 1-4
1.4.2 Optional Accessories ..... 1-4

SECTION 2 INITIAL INSTRUCTIONS

2.1 Receiving Inspection ..... 2-1

2.2 Power Requirement

2.2.1 Fuses ..... 2-1

2.3 Chassis Grounding ..... 2-1

2.4 Rack Mounting ..... 2-1

2.5 Returning the Instrument ..... 2-1

SECTION 3 OPERATION

3.1 Front and Rear Panel Controls, Connectors, and Indicators ..... 3-4

3.1.1 Front Panel Description and Key Functions ..... 3-4
3.1.2 Rear Panel Description ..... 3-7

3.2 Initial Procedures ..... 3-8

# TABLE OF CONTENTS (con't.)

Page Number

3.3 General Operating Procedures ..... 3-8

3.3.1 Introduction ..... 3-8
3.3.2 Instrument Default Settings ..... 3-8
3.3.3 Manual Self Test ..... 3-9

3.4 Measurement Procedures

3.4.1 Introduction ..... 3-9
3.4.2 Preparation for taking Measurements ..... 3-9
3.4.3 Absolute Power Measurements ..... 3-9
3.4.4 Peak Power Measurements ..... 3-9
3.4.5 Transmission Loss/Gain ..... 3-9
3.4.6 Comparison or Ratio Measurements ..... 3-10

3.4.6.1 Referenced to 0dB ..... 3-10
3.4.6.2 Referenced to an Offset Value ..... 3-10

3.4.7 Other Applications ..... 3-10

3.4.7.1 Sweeper Leveling ..... 3-10
3.4.7.2 Recording ..... 3-10
3.4.7.3 RF Blanking ..... 3-10

APPENDIX A POWER MEASUREMENT UNCERTAINTIES

A.1 General ..... 3-11

A.1.1 Instrumentation Errors ..... 3-11
A.1.2 RF Losses ..... 3-11
A.1.3 Mismatches ..... 3-11
A.1.4 Power Reference Uncertainty ..... 3-11
A.1.5 Calculating Measurement Uncertainty ..... 3-11

A.1.5.1 Typical Uncertainty Calculations ..... 3-12

SECTION 4 GPIB BUS INTERFACE

4.1 Introduction ..... 4-1

4.2 IEEE Bus Functions ..... 4-1

# TABLE OF CONTENTS (con't.)

Page Number

4.3 GPIB Operation

4.3.1 Setting the GPIB Address ..... 4-2
4.3.2 Remote Operation ..... 4-2
4.3.3 GPIB Program Codes ..... 4-2
4.3.4 Data Entry and Terminators ..... 4-3
4.3.5 GPIB Error Codes ..... 4-3
4.3.6 Detailed Description of GPIB Codes

4.3.6.1 UN (Set Units) ..... 4-3
4.3.6.2 DR (Enter dB Offset) ..... 4-3
4.3.6.3 ST (Store Current Settings) ..... 4-3
4.3.6.4 RL (Recall Stored Settings) ..... 4-3
4.3.6.5 SR (Set Range) ..... 4-3
4.3.6.6 AV (Set Average Number) ..... 4-4
4.3.6.7 LF (Enter Linearity Factor) ..... 4-4
4.3.6.8 DC (Enter Duty Cycle) ..... 4-4
4.3.6.9 CF (Enter Sensor Calibration Factor) ..... 4-4
4.3.6.10 PR (Power Reference On/Off) ..... 4-4
4.3.6.11 AC (Auto Calibration) ..... 4-4
4.3.6.12 AZ (Autozero) ..... 4-4
4.3.6.13 RE (Reset) ..... 4-4
4.3.6.14 TR (Trigger Mode) ..... 4-4
4.3.6.15 RS (Read Settings) ..... 4-5
4.3.6.16 RC (Read Calibration Data) ..... 4-5
4.3.6.17 SQ (Set SRQ Mask) ..... 4-5

4.4 Reading Data ..... 4-6

4.5 Serial Poll ..... 4-6

4.6 Talk Only ..... 4-6

SECTION 5 ELECTRICAL DESCRIPTION

5.1 Model 8531 Power Meter System Description ..... 5-4

5.2 Analog PC Board Description ..... 5-4

5.2.1 First Amplifier ..... 5-4
5.2.2 Spike Blanking ..... 5-5
5.2.3 First Attenuator ..... 5-5
5.2.4 Second Amplifier ..... 5-5
5.2.5 Second Attenuator ..... 5-5

## TABLE OF CONTENTS (con't.)

Page Number

5.2.6 Third Amplifier ..... 5-5
5.2.7 Fourth Amplifier ..... 5-5
5.2.8 Phase Synchronous Detector ..... 5-5
5.2.9 Comparator and A-D Conversion ..... 5-6
5.2.10 Power Sensor Zener Diode Drive ..... 5-6
5.2.11 Timing Logic ..... 5-6
5.2.12 D-A Converters ..... 5-7
5.2.13 Serial D-A Function ..... 5-7
5.2.14 Power Supplies ..... 5-8
5.2.15 Power Reference ..... 5-9
5.2.16 Processor PC Board ..... 5-9

5.2.16.1 Address Decoding ..... 5-10
5.2.16.2 Wait States ..... 5-10
5.2.16.3 Address and Data Buffering Functions ..... 5-11
5.2.16.4 EPROM Functions ..... 5-11
5.2.16.5 RAM Functions ..... 5-11
5.2.16.6 Reset Control ..... 5-11

5.2.17 PPI Functions ..... 5-13
5.2.18 Keyboard & Display PC Board Functions ..... 5-13
5.2.19 GPIB Interface Module ..... 5-13

5.2.19.1 Data Bus Function ..... 5-14
5.2.19.2 Interface Management Bus Functions ..... 5-14
5.2.19.3 Handshake or Data Transfer Bus ..... 5-15
5.2.19.4 Bus Operation ..... 5-15
5.2.19.5 Handshake Procedure ..... 5-15

5.3 Software Description

5.3.1 Software Program Initial Sequence ..... 5-16
5.3.2 Software Program Measuring Sequence ..... 5-16

SECTION 6 PERFORMANCE VERIFICATION TESTS

6.1 Introduction ..... 6-1

6.1.1 Equipment Required ..... 6-1

6.2 Test Procedures ..... 6-1

# TABLE OF CONTENTS (con't.)

Page Number

6.2.1 Power-On Performance Checks ..... 6-1

6.2.1.1 Power-On Display Check ..... 6-1
6.2.1.2 Autozeroing Check ..... 6-1
6.2.1.3 Autocalibration Check ..... 6-2

6.2.2 Factory Pre-Set Adjustment and/or Test Checks ..... 6-2

6.2.2.1 Zero Set/Carryover ..... 6-2
6.2.2.2 Instrumentation Accuracy ..... 6-2

Performance Verification Test Data Recording Sheet ..... 6-5

SECTION 7 MAINTENANCE

7.1 Introduction ..... 7-1

7.2 Periodic Maintenance ..... 7-1

7.3 **CALIBRATION** ..... 7-1

7.3.1 Internal TEST Mode ..... 7-2
7.3.2 Test Equipment Required ..... 7-4
7.3.3 Voltage Checks and Adjustments ..... 7-4

7.3.3.1 210V to 230V Range Setting ..... 7-4
7.3.3.2 110V to 130V Range Setting ..... 7-4

7.3.4 Timing Adjustments ..... 7-5
7.3.5 Filter Balance Adjustment (TEST Mode "0") ..... 7-5
7.3.6 13 Bit D/A Adjustment (TEST Mode "5") ..... 7-5
7.3.7 Recorder D/A Adjustment (TEST Mode "1") ..... 7-5
7.3.8 Power Reference Adjustment ..... 7-6

7.3.8.1 Frequency ..... 7-6
7.3.8.2 Output Level (Initial Setting) ..... 7-6
7.3.8.3 Harmonics ..... 7-6
7.3.8.4 Output Level (Final Adjustment) ..... 7-6

7.4 Troubleshooting ..... 7-6

7.4.1 Equipment Required ..... 7-7
7.4.2 Check for Defective Sensor ..... 7-7
7.4.3 Power Supply Faults ..... 7-7

## TABLE OF CONTENTS (con't.)

Page Number

7.4.4 Signal Channel Faults ..... 7-7
7.4.5 Processor Board Faults ..... 7-8

Calibration Data Recording Sheet ..... 7-11

SECTION 8 SCHEMATIC DIAGRAMS (SD) & COMPONENT LAYOUTS

Index to SD & Component Layout Drawing Locations ..... 8-1

SECTION 9 REPLACEABLE PARTS LISTINGS

Index to Location of Replaceable Part Descriptions ..... 9-1

SECTION 10 MANUAL CORRECTIONS ..... follows 9-9

### LIST OF TABLES AND ILLUSTRATIONS (FIGURES)

Table 3-A Resolution and Response Times for All Ranges, Average Factor = 1 ..... 3-6
Table 3-B Resolution and Settling Times for Range 1, Average Factor Variable ..... 3-6
Table 3-C Error Codes ..... 3-8

Table 4-A GPIB Program Codes ..... 4-2
Table 4-B GPIB Error Codes ..... 4-3

Table 5-A Attenuator Control ..... 5-5
Table 5-B Power Sensor Zener Diode Voltages ..... 5-6
Table 5-C PPI Port Allocations ..... 5-13

Table 6-A Error Codes ..... 6-1

Table 7-A TEST Mode Functions ..... 7-2

Figure 3-1 Model 8531 Front and Rear Panel Controls, Connectors, and Indicators ..... 3-3
Figure 3-2 Typical Measurement Setup Using the Recording & RF Blanking Functions of the Model 8531 ..... 3-10
Figure 3-3 Typical Offset Test Setup Used for High Power Readings ..... 3-10

Figure 5-1 Model 8531 Power Meter Block Diagram ..... 5-3

## LIST OF TABLES AND ILLUSTRATIONS (FIGURES) (con't.)

Page Number


| | | |
|---|---|---|
| Figure 5-2 | First Amplifier Simplified Block Diagram | 5-4 |
| Figure 5-3 | Spike Blanking | 5-5 |
| Figure 5-4 | Overall Timing Signal Relationships | 5-7 |
| Figure 5-5 | Serial D-A Converter Diagram | 5-7 |
| Figure 5-6 | Step-Up Voltage Regulator | 5-8 |
| Figure 5-7 | Step-Down Voltage Regulator | 5-9 |
| Figure 5-8 | CPU Timing: Wait State and Fetch Instruction | 5-10 |
| Figure 5-9 | Memory Decoding | 5-11 |
| Figure 5-10 | Simplified Reset Control Circuit | 5-12 |
| Figure 5-11 | GPIB Interface Bus Structure | 5-14 |
| Figure 5-12 | Typical Handshake Cycle | 5-16 |
| Figure 7-1 | Locations of Test Points and Adjustment Potentiometers on the Analog PC Board | 7-3 |
| Figure 7-2 | Filter Adjustment | 7-5 |
| Figure 7-3 | Power Reference Calibration Component Locations | 7-6 |
| Figure 7-4 | Signal Channel Waveforms | 7-9 |
| Figure 8-1 | Analog PC Board Component Layout | 8-2 |
| Figure 8-2 | Processor PC Board Component Layout | 8-10 |
| Figure 8-3 | Keyboard and Display Assembly Component Layout | 8-15 |
| Figure 8-4 | Power Reference Assembly Component Layout | 8-17 |
| Figure 8-5 | GPIB Interface Component Layout | 8-19 |

# 1. GENERAL INFORMATION

## 1.1 WAVETEK MICROWAVE, INC. (WMI) MODEL 8531 POWER METER

The Model 8531 is a precision digital power meter capable of making measurements over a wide frequency and power range. The range is dependent upon the particular power sensor being used.

All information is displayed on a 4 digit liquid crystal display (LCD). Correction factors and control operations are made through a dual function keypad. Each key is initially used to perform a specific function, and then can be used for numeric input.

The instrument is microprocessor controlled to ensure simplicity and ease of use and, at the same time, enhance the overall accuracy. Measurements can be made and displayed directly in dB, Watts, or dB Relative. The dB Relative mode allows readings to be taken in relation to a user-selected reference value. The dB Relative mode also allows offset values to be entered in dB so that direct power readings can be taken.

The 8531 has a non-volatile memory so that up to ten front panel configurations can be stored and recalled at any time. Memory zero (the memory used to establish the power-up status of the power meter), can be set either to restore 1) the factory default settings, or 2) the power meter status immediately prior to power-down. Memories 1 through 9 store user-defined configurations.

A built-in 1mW, 50MHz RF Power Reference is included, traceable to the National Bureau of Standards (NBS).

Resolution is automatic and is selected to give the fastest and most significant display depending upon the range where measurements are being made.

Autoranging is the standard power-on condition of the 8531, but any specific range can be selected to enable the analog peaking meter to be used for circuit peaking adjustments.

Autozero information is stored digitally for each range to reduce the drift and zero carry-over errors normally encountered when the zeroing is performed by an analog circuit.

The Autocal feature turns on the power reference automatically for a period of time sufficient to set the internal amplifier gain stages to exactly 1mW (0 dB), and then returns the instrument to the mode in which it was operating before "Autocal" was initiated.

The power accuracy linearity feature allows the 8531 to correct for the linearity factor of each individual power sensor, thus providing increased accuracy. Calibration factors included with each sensor are entered numerically through the keypad to a resolution of 0.01% for further accuracy.

All front panel functions of the 8531 can be remotely controlled by the General Purpose Interface Bus (GPIB) if the unit has been specified with option 001. (This option can also be ordered later and installed by the user if desired.)

Self diagnostics are automatically performed each time the instrument is turned on, and internal health checks can be made as required or desired.

For fast leveling applications or recording over the full dynamic range of the instrument, two analog output connections are available on the rear panel.

## 1.2 SPECIFICATIONS

### 1.2.1 Instrument Specifications

Frequency Range:

30kHz to 26.5GHz
(Dependent upon the power sensor being used. See Section 1.2.2 on page 1-4.)

Power Range:

+20 to -70dBm
(Dependent upon the power sensor being used. See Section 1.2.2 on page 1-4.)

Dynamic Range:

50dB in five 10dB full scale ranges

Display Resolution:

User selectable from 1dB to 0.001dB

Accuracy:

Power Reference:

Output: 1mW (factory set to ± 0.7%)
Traceable to NBS

Accuracy: ±1.2% worst case for 1 year

Frequency: 50MHz, nominal

Connector: Type N (f) precision, 50Ω

Instrumentation Accuracy:

Watts Mode: ±0.5%

dB Mode: ±0.02dB

dB Relative Mode: ±0.02dB

Zeroing Accuracy:

Zero Set: ±1% full scale on most sensitive range

Zero Carryover: ±0.03% full scale on most sensitive range

Zero Drift: Sensor Dependent

±0.1% for 8531X sensors
±2% for 85320 sensor

(Represents percent of full scale on most sensitive range. Decrease percentage by a factor of 10 for each higher scale.)

Noise Uncertainty:

<1% full scale on most sensitive range with an averaging factor >19.

Outputs:

Fast Leveling Output:

0 to 1V linearly proportional to power on each range. Accuracy: ±0.5% (excludes Cal Factor and Linearity Data). BNC connector.

Recorder Output: (BNC connector)

±1.0% dB mode: 1 V/decade, 7V maximum on Range 5 (highest range)

Watts Mode: 0 to 5V linearly proportional to power over the full 50dB dynamic range

(When held on Range 5 and overrange, recorder output goes to +10V. When held on Range 1 and underrange, recorder output goes to 0V.)

Blanking Output:

Pulls low during power meter autozero. Can be used to shut off the sweep generator RF during sensor zeroing. Open collector output. Maximum voltage 25V, maximum current 50mA

Response Time:

Range 1: 1s, selectable

Range 2 through 5: 250ms (display update), selectable. 25ms using GPIB

Remote Operation:

GPIB Interface:

Compatible with IEEE 488-1978. Equipped when option 001 is specified. Optional as P/N 19947. All front panel settings can be remotely controlled.

GPIB Measurement Speed:

40 readings/second. 6 trigger modes include fast readings, settled readings, triggered and free running.

Averaging:

User selectable from 1 to 253 readings to smooth noisy measurements. Increased averaging automatically selects increased reading resolution down to 0.001dB.

Duty Cycle:

Allows direct display of peak pulse power for pulsed signals, calculated from measured average power. Meter accepts duty cycle values in the range of 0.001% to 100%.

Linearity Factor:

Allows precise correction for slight departure from linearity found in top 10dB of dynamic range in any thermocouple or diode sensor.

dB REL and Offset:

Allows both relative readings and offset readings. Power display can be offset by -99.9dBm to +99.9dBm to account for external attenuation, coupling, or gain.

Storage Registers:

Allows storage and recall of 10 front panel settings of the instrument.

Cal Factor:

Allows direct entry of sensor Cal Factor (frequency response correction).

Auto Cal:

Automatic, one pushbutton (or programmable) calibration of sensor and meter using built-in 1mW power reference.

Auto Zero:

Automatic, 1 pushbutton (or programmable) zeroing of sensor and meter.

Environmental:

Temperature:

Operating: 0 to 50°C
(+32 to +122°F)

Storage: -40 to +70°C
(-40 to +158°F)

Humidity:

Up to 95% relative humidity at 35°C (95°F)

Altitude:

Up To 2500 meters (pressurized freight at 27kPa differential i.e. 3.9 lbf/in2)

Power Requirements:

Voltage: (AC Supply Ranges - switchable)

105 to 120V or 210 to 240V +/-10%

Frequency: 45 to 440Hz

Consumption: 25VA, maximum

Dimensions: (H x W x D)

Including feet and handle:

108 x 256 x 359 mm
(4.25 x 10.08 x 14.13 in)

Without feet and handle:

88 x 216 x 359 mm
(3.46 x 8.50 x 14.13 in)

Weight:

3.2 kg (7.05 lbs)

### 1.2.2 Power Sensor Specifications

| Model Number | Frequency Range | Power Range | Maximum Power | Linearity Factor Accuracy | Maximum VSWR | RF Connector | Dimensions | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Length | Diameter | Weight |
| 85310 | 10 MHz to 20 GHz | −30 to +20 dBm (1 μW to 100 mW) | +24.8 dBm (300 mW) | ±0.5% at 25°C | 1.25; 10 MHz–30 MHz<br>1.10; 30 MHz–2 GHz<br>1.18; 2 GHz–16 GHz<br>1.28; 16 GHz–18 GHz<br>1.40, typical to 20 GHz | Type N(m) | 87 mm (3.4) in. | 33.5 mm (1.3) in. | 0.14 kg (0.30 lb) |
| 85312 | 30 kHz to 4.2 GHz | −30 to +20 dBm (1 μW to 100 mW) | +24.8 dBm (300 mW) | ±0.5% at 25°C | 1.60; 30 kHz–100 kHz<br>1.20; 100 kHz–300 kHz<br>1.10; 300 kHz–4.2 GHz | Type N(m) | 87 mm (3.4) in. | 33.5 mm (1.3) in. | 0.14 kg (0.30 lb) |
| 85313 | 10 MHz to 26.5 GHz | −30 to +20 dBm (1 μW to 100 mW) | +24.8 dBm (300 mW) | ±0.5% at 25°C | 1.40; 10 MHz–50 MHz<br>1.15; 50 MHz–100 MHz<br>1.10; 100 MHz–2 GHz<br>1.15; 2 GHz–12.4 GHz<br>1.20; 12.4 GHz–18 GHz<br>1.25; 18 GHz–26.5 GHz | APC-3.5(m) | 80 mm (3.2) in. | 33.5 mm (1.3) in. | 0.14 kg (0.30 lb) |
| 85319 | 30 kHz to 3 GHz | −30 to +20 dBm (1 μW to 100 mW) | +24.8 dBm (300 mW) | ±0.5% at 25°C | 1.40; 30 kHz–100 kHz<br>1.15; 100 kHz–300 kHz<br>1.10; 300 kHz–2 GHz<br>1.20; 2 GHz–3 GHz | 75 ohm Type N(m) | 88 mm (3.5) in. | 33.5 mm (1.3) in. | 0.14 kg (0.30 lb) |
| 85320 | 10 MHz to 20 GHz | −70 to −20 dBm (100 pW to 10 μW) | +23 dBm (200 mW) | ±0.5% at 25°C | 1.4 to 1.2;<br>10 MHz–40 MHz<br>1.20; 40 MHz–10 GHz<br>1.35; 10 GHz–18 GHz<br>1.40, typical to 20 GHz | Type N(m) | 104 mm (4.1) in. | 33.5 mm (1.3) in. | 0.18 kg (0.38 lb) |

## 1.3 OPTIONS

(These options are also retrofittable. They can be ordered by the part numbers listed.)

Option 001: GPIB (GPIB Module: P/N 19947)

Option 002: Rear Panel Sensor Input Assy. P/N 19932

## 1.4 ACCESSORIES

### 1.4.1 Supplied Accessories

AC Supply Lead, P/N 19945

Operating & Maintenance Manual, P/N 19946

2 Meter Power Sensor Cable, P/N 19935-1

### 1.4.2 Optional Accessories

5 Meter Power Sensor Cable, P/N 19935-2

15 Meter Power Sensor Cable, P/N 19935-3

50 Meter Power Sensor Cable, P/N 19935-4

Rear Panel Sensor Input Assy., P/N 19932

Rack Mounting Kit (Double Unit), P/N 19936

Blank Frame Kit for Double Unit Rack Mount, P/N 19937

Rack Mounting Kit (Single Unit), P/N 19938

Stowage Cover, P/N 19939

# 2. INITIAL INSTRUCTIONS

## 2.1 RECEIVING INSPECTION

Inspect the instrument for shipping damage. Be sure that all portions of the shipment are located before discarding any packing material or shipping containers. (See Section 6 if a Performance Evaluation is required.)

## 2.2 POWER REQUIREMENT

**WARNING: Before applying ac mains power to the instrument, be sure that the instrument is set for the correct line voltage.** (See below)

The unit is set at the factory for operation at the normal supply voltage for the country in which it is sold. The input frequency must be between 45 and 440Hz. Conversion between 115V and 230V can be accomplished by resetting the switch on the rear panel of the unit.

### 2.2.1 Fuses

The correct fuse rating for either 115V or 230V supply voltage is marked on the rear panel. The supply voltage ranges with their corresponding fuse ratings are as follows:

230V: 250ma Slo-Blo

115V: 500ma Slo-Blo

## 2.3 CHASSIS GROUNDING

**DANGER: FAILURE TO PROPERLY GROUND THE INSTRUMENT CAN ALLOW HIGH VOLTAGE LEVELS TO BUILD UP ON THE CHASSIS. THE VOLTAGE LEVELS COULD BE DANGEROUS TO OPERATING PERSONNEL.**

The instrument is supplied with a three-conductor NEMA type power cord. The current carrying conductor is black, and its return is white.

The green wire of the power cord is for connection to earth ground. The instrument will be properly grounded if the plug is connected to a properly installed three-prong receptacle. If a three-prong to two-prong adapter is used, be sure that the pigtail of the adapter is earth grounded.

## 2.4 RACK MOUNTING

The instrument is supplied ready for bench mounting. If rack mounting is required, two rack mounting kits are available as optional accessories. One kit consists of two similar instruments in a side by side configuration (one can be the 8531, the other can be another instrument of the same size or a dummy instrument). The other rack mounting kit will position the 8531 in the center of the rack, blanking the empty spaces on either side of the unit. Mounting instructions are included with the kits. (See Section 1.4.2 on page 1-4 for part numbers.)

## 2.5 RETURNING THE INSTRUMENT

If it is felt that the instrument should be returned to Wavetek Microwave for any reason, it is recommended that the Wavetek Microwave Customer Service Department be contacted before the unit is sent back. It is often the case that many problems can be resolved by telephone or Telex without the necessity of returning the instrument. The telephone number is (408) 734-5780, extension 260, or Telex 371-6460.

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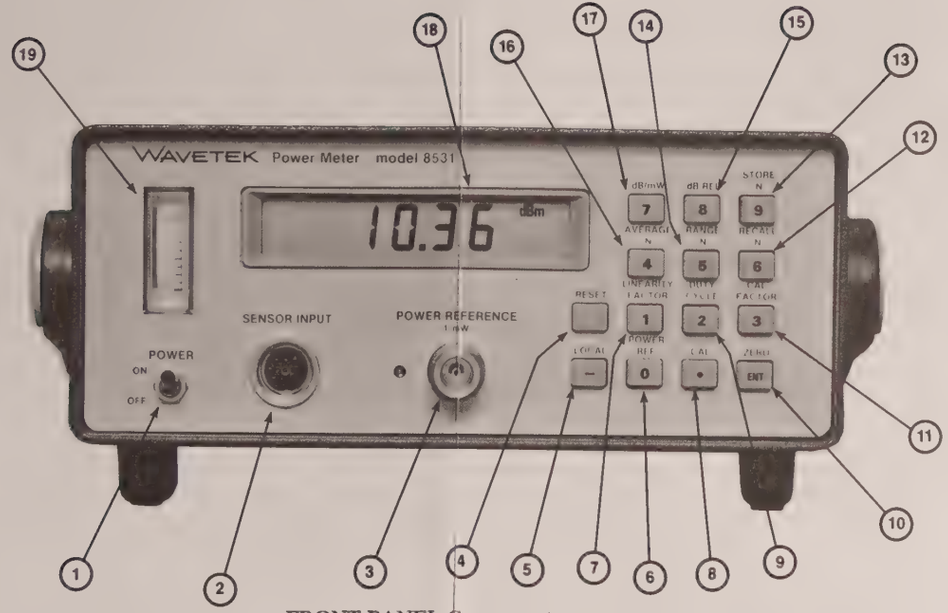
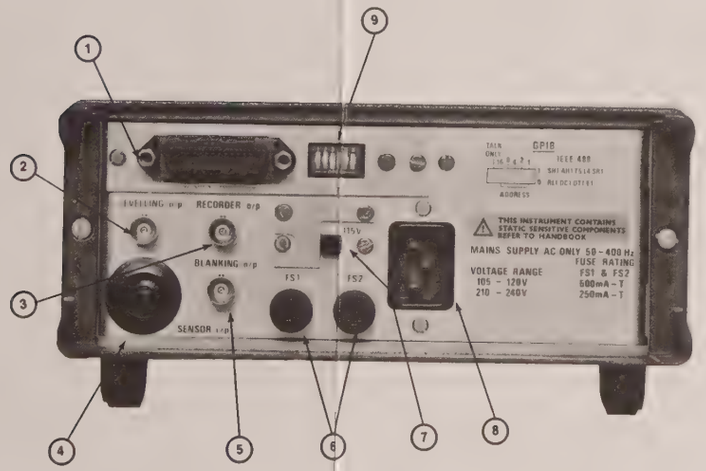
Please turn to page 3-4




FRONT PANEL Components




REAR PANEL Components

*Figure 3-1. Model 8531 Front and Rear Panel Controls, Connections, and Indicators*





# 3. OPERATION

## 3.1 FRONT AND REAR PANEL CONTROLS, CONNECTORS, AND INDICATORS

(Refer to corresponding numbers in Figure 3-1 on page 3-3)

### 3.1.1 Front Panel Description and Key Functions

1. **POWER** Switch

This toggle switch applies the ac mains operating voltage to the instrument for both the manual and remote modes of operation.

2. **SENSOR INPUT** Connection

Provides the power sensor input connection to the 8531.

3. **50MHz, 1mW POWER REFERENCE**

This is the power sensor connection that is used to calibrate the instrument's gain to match the sensor characteristics of the particular power sensor being used.

4. **RESET** Key

Returns the instrument to the power-on status. If the default values have not been changed by the operator, the routine will be returned to the default parameters when RESET is pressed (see Section 3.3.2 on page 3-8). If the values have been changed, the routine will return to the last settings that were entered.

5. **LOCAL** Key

When the instrument is equipped with the GPIB option and is being controlled by a remote controller/calculator, all front panel controls are locked out (LCD display will indicate "remote"). The LOCAL key is pressed when it is desired to restore manual operation of the front panel controls.

6. **POWER REF** Key

This key is used to toggle the 1mW, 50MHz power reference function either on or off. The function can be used to verify the calibration results after the Autocal routine has completed (see #8, AUTOCAL Key, below). Use of the dB/mW key (see #17, **dB/mW** Key, on page 3-6) allows the reading to be displayed in either dB or mW.

7. **LINEARITY FACTOR** Key

This key can be used when it is desired to enter a new linearity factor for the sensor currently being used. The instrument's default value for sensor linearity is 8. The actual measured value for the linearity factor appears on the sensor housing next to the cal factor graph. If this value is something other than 8, the measurement accuracy can be improved by changing the linearity factor setting as follows:

Press: LINEARITY FACTOR → n.nn → ENTER

(n.nn = new linearity value

8. **CAL** Key

This key is used to automatically calibrate the electrical characteristics of the power sensor to those of the power meter. The sensor is connected to the POWER REFERENCE input, CAL is pressed, and the display will indicate "CAL" while the routine is being carried out. After the routine has completed, the POWER REF key can be used to verify the results (see #6, POWER REF Key, above).

NOTE: Before the sensor is CAL'd, make sure that the appropriate Cal Factor is entered. The Cal Factor at 50MHz is not always 100%, and can be read from the sensor label or calibration table supplied with the sensor.

9. **DUTY CYCLE** Key

When measuring pulsed power, this key can be used to enter a duty cycle figure to allow the display of the peak pulse power reading as derived from the duty cycle percentage. When DUTY CYCLE is pressed during a test routine, the display will show the current duty cycle percentage. At initial power-on, the default figure will be preset to 100% for CW

measurements. For peak power, any value of duty cycle between 0.001% and 100% can be entered. Peak power waveforms with a very low repetition rate can be measured by selecting the appropriate averaging factor. The sequence is:

DUTY CYCLE → nn.nn → ENTER

(nn.nn = % value of duty cycle)

**10. ZERO** Key

This key is used to automatically zero each of the 5 power reading ranges available in the instrument. When ZERO is pressed, the display will initially show five dashes "- - - - -". As each of the ranges is zeroed, one of the dashes will disappear to indicate zeroing complete for that range. When all five dashes have disappeared the instrument will return to its normal power reading mode. The sequence is:

ZERO → (wait for dashes to disappear)

**11. CAL FACTOR** Key

Each individual power sensor is furnished with a calibration curve to indicate the Calibration Factor over the frequency range specified for that sensor. This correction figure includes how much RF to dc conversion takes place at each discrete frequency point. Accuracy is enhanced because, using the CAL FACTOR key, the Cal Factor can be entered to a resolution of 0.01% to avoid the errors inherent in scale interpretations or switching steps. The sequence is:

CAL FACTOR → nn.nn → ENTER

(nn.nn = new cal factor number)

**12. RECALL** Key

This key can be used to recall any one of 10 front panel test setups stored in the memory of the instrument. Memory location 0 contains all of the most recent instrument settings including Autozero and Autocal information. Memory locations 1 through 9 contain any previously stored test setups. Standard power-off and power-on default recall conditions are described in #13, STORE Key, described next. The keypad sequence is:

RECALL → n → ENTER

(n = memory location 1 - 9)

**13. STORE** Key

The non-volatile memory of the 8531 is backed up by a battery supply with a 10 year life span. Any current front panel setup can be stored in non-volatile memory by pressing STORE and the memory location number (1 through 9) where it is desired to store the settings. The keypad sequence is:

STORE → n → ENTER

(n = memory location 1 - 9)

Memory location 0 (the memory used to set the power-up status of the power meter) will either restore: 1) the factory default settings (see Section 3.3.2 on page 3-8) or, 2) the power meter status immediately prior to power-down.

To establish the factory default settings as the power-up mode, activate the following after turning on the power meter:

.

STORE → − (dash)

(ENTER is not required)

The factory default values will be written to Memory location 0 to establish a known power-up condition independent of the status at power-down.

To enable the power-up setting to be the same as the status at power-down, activate the following after turning on the power meter:

STORE → . (point)

(ENTER is not required)

Now Memory location 0 will be updated anytime any of the default settings are changed.

To establish user-defined settings after power-up, store the desired settings in locations 1 - 9 and then recall the appropriate memory location when required.

### 14. RANGE Key

The normal state of the 8531 is the autoranging mode. The RANGE key can be used to see specifically within which range a measurement is being taken, or to change the range. A typical application would be to hold a range so that the Analog Peaking meter on the front panel can be used for final RF adjustments. This would avoid any range changes due to autoranging.

To hold a range, press the RANGE key. The display will read the current range (1 through 5). Then the same range or a different range can be selected, and will be indicated by the display. For instance, if the routine were autoranging in range 4 and it were desired to hold in range 3, the sequence would be:

Press: RANGE ("4AU" is displayed)

Then press: 3 ("3HD" is displayed)

To return to autoranging:

Press: RANGE (display current hold range)

Then press: - (dash) (the display will show the autorange that has been selected by the 8531)

### 15. dB REL Key

The dB REL feature allows an offset to be made in both the Watts and dBm modes. The offset can be the gain in dB or attenuation in dB of the DUT (device under test). This allows the direct display of the true incident power reading.

To make a comparative measurement (e.g. between two RF levels at different frequencies or a drift measurement over a period of time), any power level can be referenced to 0dB by the following method: (assume display is showing some arbitrary power level)

Press: dB REL (display changes to all dashes)

Then press: ENTER (display shows "0000" and indicates "dBrel")

Instead of a separate numerical entry, ENTER also references to 0dB.

To make an offset measurement requiring an attenuation value, press:

dB REL → - → n.nn → ENTER

(n.nn = the desired attenuation offset)

To make a gain measurement, the procedure is the same as the preceding only the minus sign entry is eliminated.

### 16. AVERAGE Key

This key is used to select the number of samples that will be taken prior to the display of a measurement reading. Table 3-A shows the resolution attained and the time required if just one sample were taken on each range. Table 3-B shows the measurement resolution that can be obtained and the sampling time required if more than one sample is taken. Up to 254 samples can be specified. The tables were generated using the 85310 power sensor.

*Table 3-A. Resolutions and Response Times for All Ranges, Average Factor = 1*

| AVG. FACTOR | RANGE | POWER LEVEL dBm | RESOLUTION dB | RESPONSE TIME |
|---|---|---|---|---|
| 1 | 5 | +10 to +20 | 0.01 | 250ms |
| 1 | 4 | +0 to +10 | 0.01 | 250ms |
| 1 | 3 | -10 to +0 | 0.01 | 250ms |
| 1 | 2 | -20 to -10 | 0.1 | 250ms |
| 1 | 1 | -30 to -20 | 1.0 | 1s |

*Table 3-B. Resolutions and Settling Times for Range 1, Average Factor Variable*

| AVG. FACTOR | RANGE | POWER LEVEL dBm | RESOLUTION dB | SETTLING TIME |
|---|---|---|---|---|
| 1 | 1 | -30 | 1 | 1s |
| 4 | 1 | -30 | 0.1 | 1s |
| 20 | 1 | -30 | 0.01 | 5s |
| 50 | 1 | -30 | 0.001 | 12s |

The times shown in Table 3-B are based on each display update taking 250ms. Operation on the GPIB can be 10 times faster at 25ms for a single reading.

### 17. dB/mW Key

This is a toggle action key that changes the units of measurement from dB to mW and vice versa. The

conversion from linear Watts to dBm is performed by a numerical logarithmic algorithm.

In the dBREL mode, the dB/mW key toggles between a ratio reading in dB and a linear ratio in milliwatts.

**18. LCD Display**

This is the power meter's alphanumeric display screen for presenting both measurement readings and to show annunciators to remind the operator which mode or function is currently being used.

**19. Analog Peaking Meter**

This analog meter is used to indicate the direction (positive or negative) that the amplitude (power) of the current signal of interest is moving. In other words, an increase or decrease of the power that the sensor is receiving from the DUT. The meter has less filtering and, therefore, responds much faster than the LCD display. At low power levels or with a high averaging number, the peaking meter can be used to make quick RF adjustments before taking a reading.

### 3.1.2 Rear Panel Description

**1. GPIB** Interface

This connector interfaces with the GPIB module to allow remote control of the instrument. It is either factory installed in the Model 8531-001, or can be ordered as P/N 19947 and installed by the user.

**2. LEVELLING** Output

Interface can be made between this connection and the leveling input of a sweep generator for leveling the RF output of the sweep generator. This output can respond at fast rates of change and sweep speed, but correction information (e.g. Cal Factor) is not included.

**3. RECORDER** Output

When this connection is interfaced with an X-Y recorder, a plot can be made over the 8531's full dynamic range of 50dB in either the dBm or Watt mode. Full correction information (e.g. Cal Factor and Linearity Factor) is included in the output signal.

**4.** Rear **SENSOR** Input

This configuration can be specified as an option when the 8531 is to be used with rack mounted automatic test systems. When equipped, the option disables the front panel sensor input which is covered with a blank plug.

**5. BLANKING** Output

This connection is used to interface with the RF blanking input of a sweep generator to turn off the RF output during the 8531's Autozero function. This allows the power sensor to remain connected to the DUT while the instrument is being Autozeroed.

**6. AC Supply** Fuses

FS1 and FS2 protect both the live and neutral ac supply conductors. (See Section 2.2.1 on page 2-1 for details.)

NOTE: Because the instrument uses double fusing, if the fuse in the neutral line should blow certain areas within the unit will still remain at ac mains potential.

**7. AC Supply** Switch

Positioning of the locking plate allows switch selection of either 105V to 120V or 210V to 230V ac mains supply voltage.

**8. AC Supply** Input

Interfaces the instrument to a source of ac mains supply voltage as shown above, Frequency must be between 40 and 440Hz. The earth pin is internally connected to the unit's chassis.

**9. GPIB** Address Switch

This switch is equipped only if the instrument has been specified (or modified) for GPIB operation. See Section 4.3.1 on page 4-2 of the IEEE Bus Interface section for GPIB address selection instructions.

## 3.2 INITIAL PROCEDURES

After the instrument has been set for the proper ac supply voltage and checked that the correct fuses have been installed for the voltage setting, it can be connected to the ac outlet and switched on.

The first action to take place after power-on will be a self-test to check the unit's memory. If self-test should fail, an error code will be displayed. If the failure should be due to not connecting the power sensor, the error code "Er 02" would be shown. Table 3-C, below, shows all of the error codes and their indications.

*Table 3-C. Error Codes*

01 Power-On Fail

02 No RF Sensor

03 Auto-Zero Fail

04 Auto-Cal Fail

05 Manual Entry Error

12 Store/Recall Error

Correct operation of the instrument with the RF sensor connected is indicated by the self-test routine sequentially displaying:

"- - - -" (Instrument type number)

"nn" ("nn" = issue number of the software)

"Ad 9" (GPIB Address 9 -- if the GPIB option is equipped)

Once the self-test is completed, the unit is ready for calibration prior to use.

## 3.3 GENERAL OPERATING PROCEDURES

### 3.3.1 Introduction

All operations can be performed either through the front panel switches or, remotely, through the GPIB (if option 01 was specified or the GPIB module, P/N 19947, has been installed by the user). See Section 4 of this manual for specific GPIB operation.

Most front panel keys are dual function with the primary function indicated above each key. When a function is activated, it will usually have to be followed by a numeric entry terminated by pressing the ENTER key.

Any function entry recalls to the display the last numeric value that was assigned to that function. If it is desired to just retain this value the ENTER key can be pressed, or a new value can be keyed in at this time and entered by pressing the ENTER key

If a mistake is made and realized during the entry procedure, it can be cleared by pressing the ENTRY key and re-selecting the function.

If an improper entry should be made (like trying to set the Cal Factor to a value above 100%), the "05" (Manual Entry Error) error code would be displayed for a short period and then the instrument would default to the last correct numerical value that had been entered for that function.

### 3.3.2 Instrument Default Settings

At initial power-on and providing no changes in value have been previously entered by the operator, default settings generated by the instrument's non-volatile memory will be as follows:

| | |
|---|---|
| Cal Factor: | 100% |
| Duty Cycle: | 100% |
| Linearity Factor: | 8 |
| Average: | 1 |
| Autoranging: | ON |
| Units Display: | dBm |

To totally clear all of the most recent test setup values that have been entered in the instrument, the RESET key can be pressed to return the unit to the default settings given above.

### 3.3.3 Manual Self Test

Although the 8531 always automatically performs its self test function at initial power-on, it is also possible to manually self test the instrument at any desired time. This is done by simultaneously pressing the RESET key and any other key. Both keys are held until the "test" display is presented on the screen.

Pressing the " - " (dash) key then initiates the keyboard test wherein each key can be pressed in turn to display its functional characteristic (e.g. ENTER = "E").

If the "0" (zero) key is pressed while "test" is being displayed, the LCD display and annunciators are flashed to denote a healthy operating condition.

## 3.4 MEASUREMENT PROCEDURES

### 3.4.1 Introduction

Measurements that can be made with the 8531 fall into four main categories. These include:

- Absolute Power
- Peak Pulse Power
- Transmission Loss/Gain
- Comparison or Ratio Measurements

Other applications of the 8531 include:

- Fast Levelling of Sweep Generators
- Large Dynamic Range Recording with Correction Factors Included
- RF Blanking of Sweep Generators

### 3.4.2 Preparation for Taking Measurements

After the instrument has been initially set up as described in Section 3.2 on page 3-7, the power sensor is then calibrated and verified using the Autocal and Autozero functions as described in Sections 3.1.1 #8 and 3.1.1 #10 on pages 3-4 and 3-5. The 50MHz, 1mW displayed reading should have an uncertainty no greater than ±0.7%.

### 3.4.3 Absolute Power Measurements

1. Connect the sensor to the DUT and enter any required correction factors.
2. Enter the Cal Factor and Linearity Factor at the frequency of operation from the information printed on the power sensor. These can be entered with a resolution of ±0.01dB.
3. The absolute power reading that is being displayed has now been compensated for power voltage linearity, RF to dc conversion losses, and frequency response (sensitivity) effects.

### 3.4.4 Peak Power Measurements

1. Set up the instrument similar to Section 3.4.3.
2. Enter the desired averaging figure (number of samples between 1 and 254) to obtain an average power reading (see Section 3.1.1 #16 on page 3-6).
3. Enter the required value for the duty cycle (numerical entry between 0.001 and 100%).
4. The 8531 will now display the peak pulse power.

For low PRFs, a steadier display can be obtained by setting a higher average factor.

### 3.4.5 Transmission Loss/Gain

Any DUT having either attenuation or gain characteristics can be measured at a single frequency or swept over a suitable frequency band. In the latter application, the full response of the DUT can be plotted using the analog RECORDER output on the rear panel of the 8531. See Figure 3-2 on the next page for a typical test setup.

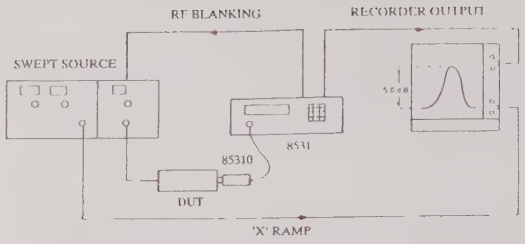



*Figure 3-2. Typical Measurement Setup Using the Recording & RF Blanking Functions of the 8531*

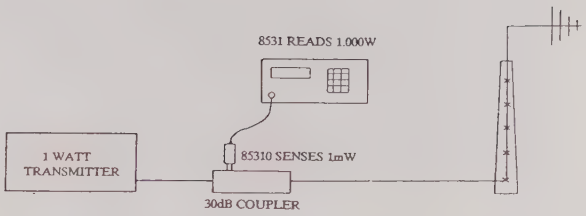



*Figure 3-3. Typical Offset Test Setup Used for High Power Readings*

### 3.4.6 Comparison or Ratio Measurements

In order to observe or plot relative changes between one power level and another, the 8531 makes the measurement in two forms:

- Referenced to 0dB
- Referenced to an offset value, +dB or -dB

These are described as follows:

3.4.6.1 REFERENCED TO 0dB

In a typical application of amplifier bandwidth, the maximum power is found and referenced to 0dB using the 8531. The frequency can then be increased and decreased as required until the 3dB points are determined. The exact frequency at which this occurs can be read from the source or via a frequency counter.

3.4.6.2 REFERENCED TO AN OFFSET VALUE

To be able to measure a higher power level than the power sensor can safely detect, either an attenuator pad or a coupler can be added ahead of the sensor. By entering the value of attenuation or coupling (in dB) as a numerical offset, the full RF power can be measured (see Section 3.1.1 #15, dB REL Key, on page 3-6). Figure 3-3 shows a typical offset measurement test setup.

To measure the input power to a DUT with only the output available and the gain known, enter this value (in dB) and the 8531 will directly display the input power to the DUT.

### 3.4.7 Other Applications

3.4.7.1 SWEEPER LEVELING

Use the LEVELLING output on the rear panel for fast leveling of voltage tunable oscillators (see Section 3.1.2 #2 on page 3-7).

3.4.7.2 RECORDING

Use the RECORDING output on the rear panel to obtain the full 50dB dynamic range of the power sensor, including all correction factors (see Section 3.1.2 #3 on page 3-4).

3.4.7.3 RF BLANKING

Use the RF BLANKING output on the rear panel to turn off the source RF while the Autozero function is being performed. This enables the power sensor to remain connected to the system.

(See APPENDIX A starting on the next page for information pertaining to power measurement uncertainties.)

# APPENDIX A

# POWER MEASUREMENT UNCERTAINTIES

## A.1 GENERAL

RF power measurement uncertainties can be affected by such things as instrumentation error, RF losses, mismatch uncertainty, and sensor calibration. The increased accuracy of any power measurement will be directly proportional to the amount that these uncertainties can be reduced. This section will describe these uncertainties and offer methods to attenuate their effect on any measurements taken with the 8531 power meter.

### A.1.1 Instrumentation Errors

Instrumentation errors come from variations in component tolerances and the calibration uncertainty of the power meter.

### A.1.2 RF Losses

RF losses are caused by the fact that some of the RF power applied to the sensor is dissipated within the various components of the sensor before it can reach the power meter's conditioning circuits, as is also the case with a certain amount of radiation losses.

### A.1.3 Mismatches

Large uncertainties can arise from either sensor or source mismatches. The first effect of these mismatches is to cause a transmission loss; i.e. the sensor does not receive the maximum available power from the source. The second effect is that multiple reflections occur between the source and the sensor which causes unpredictable transmission losses.

### A.1.4 Power Reference Uncertainty

Since the Power Refereence function is used to calibrate the meter and sensor together, the accuracy of the reference oscillator becomes part of the overall measurement uncertainty.

### A.1.5 Calculating Measurement Uncertainty

For a source and load having complex reflection coefficients of $|\Gamma_S|$ and $|\Gamma_L|$ respectively, the ratio of transmitted power to maximum available power is as follows:

$$\frac{P_L}{P_0} = \frac{(1- |\Gamma_S|^2)\ (1- |\Gamma_L|^2)}{|1- \Gamma_S\ \Gamma_L|^2}$$

This has a maximum of:

$$\frac{(1- |\Gamma_S|^2)\ (1- |\Gamma_L|^2)}{(1- |\Gamma_S||\Gamma_L|)^2}$$

And a mimimum of:

$$\frac{(1- |\Gamma_S|^2)\ (1-|\Gamma_L|^2)}{(1+ |\Gamma_S||\Gamma_L|)^2}$$

Uncertainty is usually quoted as a percentage. From the previous formulas:

Positive uncertainty = $100 * ((1+ |\Gamma S| |\Gamma L|)^2 -1)$

Negative uncertainty = $100 * ((1- |\Gamma S| |\Gamma L|)^2 -1)$

The positive and negative uncertainties are essentially the same for low reflection coefficients, but as the reflection coefficients increase the positive uncertainty increases more rapidly than the negative uncertainty. If the source and load matches are quoted as VSWRs, then they can be converted to reflection coefficients by the following formula:

$$|\Gamma| = \frac{S - 1}{S + 1}$$ where S is the VSWR

If the reflection coefficients are small, typically less than 0.15, the positive and negative uncertainties can be taken to be equal and the uncertainty can be approximated by:

Percentage uncertainty = 200 * $|\Gamma S|$ $|\Gamma L|$

A.1.5.1 TYPICAL UNCERTAINTY CALCULATIONS

1. Calculate the mismatch uncertainty for a source reflection coefficient of 0.33 and a sensor reflection coefficient of 0.05.

Positive uncertainty = $100 * ((1+0.33*0.05)^2-1)$

$= 100 * ((1+0.0165)^2-1)$

$= 100 * (1.0333-1)$

$= 3.33\%$

Negative uncertainty = $100 * ((1-0.33*0.05)^2-1)$

$= 100 * ((1-0.0165)^2-1)$

$= 100 * (0.967272-1)$

$= -3.273\%$

Calculate the uncertainties for a source VSWR of 1.3:1, and a sensor VSWR of 1.05:1.

The VSWRs must first be converted to reflection coefficients:

$$\left|\Gamma_S\right| = \frac{1.3-1}{1.3+1} = \frac{0.3}{2.3} = 0.130$$

$$\left|\Gamma_L\right| = \frac{1.05-1}{1.05+1} = \frac{0.05}{2.05} = 0.024$$

As both the source and sensor mismatches are low, the following approximation formula can be used:

Percentage uncertainty = $200 * 0.13 * 0.024$

$= 0.624\%$

# 4. GPIB (IEEE BUS) INTERFACE

## 4.1 INTRODUCTION

This section will describe the various commands required to remotely control the 8531 through the General Purpose Interface Bus (GPIB). It is strongly recommended that the user become familiar with the manual operation of the instrument (see Section 3 of this manual) before attempting to create any programs for GPIB operation.

(Included with this manual is a GPIB INSTRUCTIONS "QUICK REFERENCE CARD". This card contains a condensed version of all of the pertinent commands contained in this GPIB section, and can be utilized by the programmer as an aid to quickly locate the necessary instructions required to format his or her program for remotely controlling the 8531.)

## 4.2 IEEE BUS FUNCTIONS

Remote operation of the 8531 is accomplished through the GPIB under the control of a remote controller/calculator. Bus functions are implemented using the notation of the IEEE-488 1978 specification. Following are the bus functions that can be used with the 8531.

1. **SH1:** Source Handshake
(complete capability)

The source handshake sequences the transmission of each data byte sent from the instrument over the bus. The sequence is initiated when the function becomes active, and its purpose is to synchronize the rate at which data bytes become available to the rate at which accepting devices can receive the data.

2. **AH1:** Acceptor Handshake
(complete capability)

The acceptor handshake sequences the reading of the data bytes that are sent over the bus to be received by any accepting devices.

3. **T5:** Talker Function
(talk only function)

This function allows the 8531 to send device-dependent messages over the bus to other devices. The ability of any device to talk exists only when it has been addressed as a talker.

4. **L4:** Listener Function
(no listen only function)

The listener function provides a device with the ability to receive device-dependent messages over the bus. This capability exists only when the device is addressed to listen by the remote controller/calculator.

5. **SR1:** Service Request Function
(complete capability)

The service request function gives the 8531 the ability to inform the controller when it requires attention.

6. **RL1:** Remote/Local Function
(complete capability)

This function allows the 8531 to be controlled either manually by the front panel keys, or remotely by device-dependent messages sent over the bus.

7. **DC1:** Device Clear Function
(complete capability)

Device clear is a general reset function, and can be given to all of the devices comprising the testing system (DCL) or to specifically addressed devices (SDC). On receipt of a DCL or SDC message, the 8531 performs a software reset returning the instrument to its power-on state (similar to the 'RE' command).

8. **E1:** Open Collector Drives

The GPIB drivers equipped with the 8531's GPIB bus option have open-collector rather than tristate outputs.

NOTE: A self test failure can cause a GPIB interface error condition or suspend GPIB activity. The 8531 must be switched off to clear this condition.

## 4.3 GPIB OPERATION

### 4.3.1 Setting the GPIB Address

The instrument's talk/listen address is selected by the address switch located on the rear panel next to the GPIB connector. The 8531's address is preset at the factory to 9, but any address can be chosen within the valid limits of 0 through 30 by setting the pertinent switches to the ON position. Before changing the address, the controller manual should be checked for reserved addresses used by any of the other devices in the test system.

When the 8531 is first turned on, the current GPIB address will be shown on the display screen. If the address is changed, the instrument's internal address register will be updated whenever a device clear message is received or the instrument is again powered on.

### 4.3.2 Remote Operation

Upon receipt of an instrument command through the GPIB, the 8531 will switch to a remotely controlled operational state. This will be indicated by the "remote" annunciator being displayed on the LCD display screen. No instrument settings are changed, but all front panel keys except LOCAL are disabled and their functions placed under GPIB control.

Unless it has been inhibited by the Local Lockout (LLO) message, the instrument can be returned to local control by pressing the LOCAL key or by sending a Go To Local (GTL), Interface Clear (IFC), or Not Remote Enable (REN) message.

### 4.3.3 GPIB Program Codes

(See Section 4.3.6 on page 4-3 for detailed descriptions)

Table 4-A shows a listing of all valid GPIB program codes. These include equivalents for all front panel keys (except LOCAL) with additional codes for special functions.

Program codes can be combined in a string without individual terminators, and can include spaces or commas to improve clarity. The spaces or commas will be ignored by the instrument.

*Table 4-A. GPIB Program Codes*

| | |
|---|---|
| UNn | Set displayed units |
| DRm | Enter dB offset |
| STn | Store current settings |
| RLn | Recall stored settings |
| SRn | Set range |
| AVm | Set average number |
| LFm | Enter linearity factor |
| DCm | Enter duty cycle |
| CFm | Enter sensor calibration factor |
| PRn | Power reference on/off |
| AC | Auto calibration |
| AZ | Auto zero |
| RE | Reset |
| TRnn | Trigger mode |
| RS | Read settings |
| RC | Read calibration data |
| SQn | Set SRQ mask |
| E | Numeric entry terminator |

(n = Single byte number entry, requires no terminator)

(m = Floating point numeric entry, requires 'E' terminator)

### 4.3.4 Data Entry and Terminators

When sending a string of commands to the 8531 it is not necessary to separate each command, but commas, semi-colons, or spaces can be included to improve the legibility of the program. The maximum allowable length of the string is 78 characters.

Data can be sent to the 8531 in two forms; single number or floating decimal point. The floating point number can be up to four digits with the decimal point in any position followed by the numeric terminator 'E'. If the number is negative, it should be preceded by a minus sign. If the number is positive, no sign is required. The type of numeric entry will be defined by the particular command being sent.

### 4.3.5 GPIB Error Codes

Any invalid GPIB function will be flagged with an SRQ. By serial polling, an error code number can be read from the message string. These error codes are listed in table 4-B.

*Table 4-B GPIB Error Codes*

| | |
|---|---|
| 06 | Entry greater than 999 |
| 07 | GPIB syntax error |
| 08 | GPIB input buffer overflow (80 characters) |
| 09 | Talk only error |
| 10 | Under range |
| 11 | Over range |

### 4.3.6 Detailed Description of GPIB Codes

4.3.6.1 **UN** - (Set Units)

'UN' followed by 'n' is used to set the reading to be in either dBm or Watts. When 'n' = 0, the reading will be in dBm. When 'n' = 1, the reading will be in Watts. A typical command would be 'UN1'.

4.3.6.2 **DR** - (Enter dB offset)

When the units have been set to dBm, entering the 'DR' command will allow dB relative measurements to be made either to the entered value or to the current reading. If the units are Watts, the entered value will act as an offset. This allows the reading to be corrected if an attenuator or coupler is being used ahead of the power sensor.

A typical command would be 'DR-10E'. This command (depending on the unit setting) would set the dB relative to -10dBm, or would place a -10dB offset into a reading in Watts (i.e. if a 10dB attenuator were in the setup). The allowable range is -100 to +100dB.

4.3.6.3 **ST** - (Store current settings)

The 'ST' command allows current instrument settings to be stored in the non-volatile memory (in any desired memory location from 1 to 9) for future use. The command format is STn where 'n' is any number from 1 through 9. 'ST-' (dash) or 'ST.' (point) can be sent to change the power-on condition. 'ST-' will ensure that the power-on condition will be the same as before the instrument was last turned off. 'ST.' will return the routine to the default settings as defined in Section 3.3.2 on page 3-5 of the Operation section of this manual.

4.3.6.4 **RL** - (Recall stored settings)

The 'RL' command is used to recall the settings that were stored with the 'ST' command. 'RL0' (zero) can be used to recall the instrument settings that were in use before the last power-off or reset action was performed. The command format is 'RLn' where 'n' is a memory location number between 0 and 9.

4.3.6.5 **SR** - (Set range)

The 'SR' command sets the amplifier range. If a range number (between 1 and 5) is entered, that range will be held (range 5 has the least sensitivity). If a minus sign is entered, the amplifiers will change range automatically (autorange). The command format is 'SRn' where 'n' is 1 through 5 for a set range, and 'SR-' (dash) for autoranging.

4.3.6.6 **AV** - (Set average number)

Enters the average number (samples to be taken) between 1 and 254. The more samples taken, the higher the resolution of the displyed reading. The default value is 1. A typical command would be 'AV50E' which would set the average number to 50 and display the result after 50 samples were taken and averaged.

4.3.6.7 **LF** - (Enter linearity factor)

The 'LF' command is used to enter the RF power sensor linearity factor in the range of 5 to 14.99dB. A typical command such as 'LF8.5E' would set the linearity factor to 8.5dB.

4.3.6.8 **DC** - (Enter duty cycle)

Enters the duty cycle of the pulsed RF source to allow the display of peak power. The allowable range is 0.001% to 100%. A typical command would be 'DC0.15E' which would enter the duty cycle of 0.15%.

4.3.6.9 **CF** - (Enter sensor calibration factor)

The sensor calibration factor can be entered within a range of 70 to 100% for the frequency that is to be used. A typical command such as 'CF93.5E' would set the cal factor to 93.5%.

4.3.6.10 **PR** - (Power reference on/off)

'PRn' turns the power reference on and off. If 'n' is 1, power is turned on. If 'n' is 0, power is turned off

4.3.6.11 **AC** - (Auto calibration)

The 'AC' command activates the instrument/sensor automatic calibration (Autocal) function. The linearity and calibration factors for the sensor should be entered first, and then the Autozero function performed before Autocal is accomplished. Command syntax is 'AC'.

4.3.6.12 **AZ** - (Autozero)

Performs the instrument/sensor automatic zeroing function. Command syntax is 'AZ'.

4.3.6.13 **RE** - (Reset)

The 'RE' command resets the instrument to the initial power-on state. The current front panel settings are stored in memory location 0 (depending on the power-on mode). The command syntax is 'RE' which should be the only command sent.

4.3.6.14 **TR** - (Trigger Mode)

This command sets either sets the trigger mode or starts a measurement after a hold condition. The available trigger modes are as follows:

TR00 Normal operation (as in local)

TR1n Free run fast

TR20 Trigger immediate, then hold

TR3n Trigger immediate fast, then hold

TR40 Free run with settling time

TR60 Trigger immediate with settling time, then hold

Trigger modes 1 and 3 require a second number, 'n', which is an averaging number between 0 and 6. Zero will mean no averaging at all, and 6 is equivalent to a normal reading using the default average of 1. The normal average does not affect readings taken in the fast modes (trigger modes 2 and 4). The fast modes allow faster readings to be taken, but increase the inaccuracies of the measurement.

NOTE: TR50 is not used.

When settling time is enabled (trigger modes 40 and 60), the GPIB output buffer is not loaded with new data until the settling time has been reached. Settling time is calculated as the number of display updates required = five times the average number that was entered for TR00 and TR40. For trigger modes TR20 and TR60, settling time = average number. A measurement can be started from the hold condition by either sending a new trigger mode command, or by sending Group Execute Trigger (GET). The trigger mode returns to normal when the instrument is set to local.

4.3.6.15 **RS** - (Read settings)

This command loads the GPIB output buffer with all of the instrument settings. The next reading taken by the GPIB will be this data in a field up to 90 characters long. Each section of data contains a 2 digit prefix followed by the data and a comma as terminator. The prefixes are the same as the GPIB command except for 'RFn' and 'HFn' which indicate relative flag and range hold flag, respectively. 'RF1' indicates the routine is in the relative dB or Watts with offset mode. 'RF0' indicates that the units are normal dBm or Watts. 'HF1' indicates that the present range is being held. 'HF0' shows that autoranging is enabled.

A typical instrument setting readout would result in something like the following:

'UN0,DR-1000E-02,SR3,AV+2000E-02,
LF+9100E-03,DC+1000E-01,CF+9580E-02,
PR1,TR60,SQ1,RF0,HF0,PU1'

This string would indicate that the instrument settings were as follows:

Units set to dBm.

Last dB relative entry was -10dBm.

Range setting is 3.

Average is set to 20.

Linearity factor set to 9.1.

Duty cycle set to 100%.

Sensor cal factor set to 95.8%.

Power reference is ON.

Trigger mode is trigger immediate with settling time, then hold.

SRQ mask is set for SRQ at the end of the measurement.

Not in dB relative or Watts with offset modes.

Not in range hold mode.

NOTE: No normal data can be output until the entire string has been read out.

4.3.6.16 **RC** - (Read calibration data)

This command is the same as RS (Read settings) except that the data from the Autocal and Autozero functions is output. The prefixes used are as follows:

| | |
|---|---|
| AZ | Auto zero point |
| AC | Auto calibration point |
| 0A | Range 1 offset |
| 0B | Range 2 offset |
| 0C | Range 3 offset |
| 0D | Range 4 offset |
| 0E | Range 5 offset |

4.3.6.17 **SQ** - (Set SRQ mask)

This command sets the point where SRQs will be raised. The options are on end of measurement, on error, or on end of GPIB operation. To cancel all SRQs (default to power-on), send 'SRQ'. Each SRQ option has a binary weighted value. These values are specified as:

1 = On end of measurement

2 = On error

4 = On end of GPIB operation

To send the correct mask, add the binary values of the options required and send 'SQ' followed by the result obtained from adding the binary values. For example, 'SQ3' would specify that SRQs be sent at the end of the measurement or when any error conditon was present. The end of GPIB operation SRQ is useful to indicate the end of an instruction that takes a comparatively long time to complete (e.g. Autozero).

## 4.4 READING DATA

When measurement data is read from the 8531, various status data is also sent. A typical output string might be 'VDW+3020E-3'. The meanings of the status indications in the output string are as follows:

1st Character:

V = valid data

S = waiting for settling time

U = under range

D = over range

K = waiting for valid reading after GPIB or keyboard operation

2nd Character:

A = instrument is on range 1

B = instrument is on range 2

C = instrument is on range 3

D = instrument is on range 4

E = instrument is on range 5

3rd Character:

D = units are in dBm

R = units are in dB relative

W = units are in Watts

O = units are in Watts with offset

The rest of the string is the data in exponential format. Therefore, the reading of 'VDW+3020E-3' indicates a valid measurement of 3.02mW on range 4.

NOTE: The 8531 must be set to REMOTE or receive a Group Execute Trigger (GET) before any data can be output. After receipt of data, send REMOTE or GET again to receive more data.

Typical String: VDW+3020-3 crlf (EOI)

[EOI is sent with line feed (lf)]

## 4.5 SERIAL POLL

In response to a Service Request (SRQ), the controller should perform a serial poll of each each instrument capable of generating that SRQ. A single byte of data is returned from each instrument to indicate if it generated the SRQ and, if so, why. For the 8531, the binary data would be:

Bit 7: Always zero

Bit 6: 1 indicates SRQ active

Bit 5: 1 indicates an error has caused the SRQ. 0 for normal operation.

Bit 4: Always zero

Bits 0 - 3: Error number if SRQ is due to an error. 0 if end of measurement, or 1 for the end of a GPIB instruction.

## 4.6 TALK ONLY

In the talk only mode data is output in the normal format, but only at the end of a settling time. The trigger mode is set to Free Run with settling time (see 'TR40' GPIB command in Section 4.3.6.14 on page 4-4).

CAUTION: When sending commands to the 8531, the programmer must ensure that no spaces are sent in the middle of any commands. This can occur on some controllers when sending numeric variables over the GPIB.

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Please turn to page 5-4

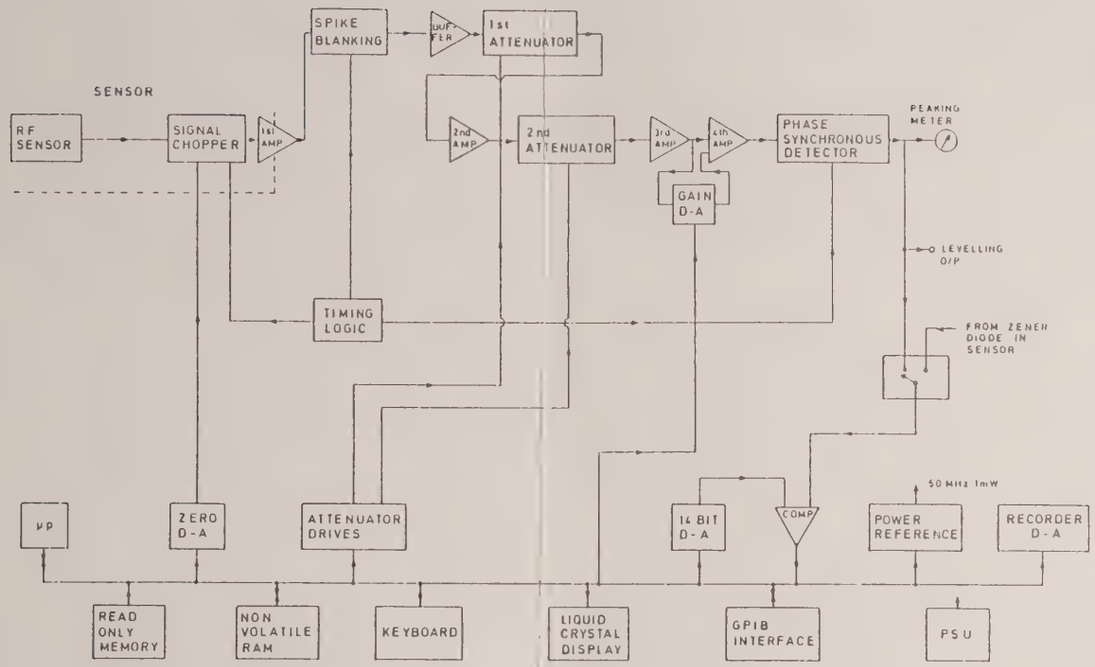


*Figure 5-1. Model 8531 Power Meter Block Diagram*





# 5. ELECTRICAL DESCRIPTION

## 5.1 MODEL 8531 POWER METER SYSTEM DESCRIPTION

(Refer to Figure 5-1 on page 5-3)

The RF Power Sensor generates a low dc voltage when power is applied to it. This voltage is converted to an ac signal by the Signal Chopper which allows high gain, low noise amplifiers to be used in the system.

The chopped signal then goes to the 1st Amplifier. This amplifier is composed of two sections; the first section is located in the RF Sensor housing, and the second section is in the power meter. The Spike Blanking circuit following the 1st Amplifier removes spikes that can occur on the edges of the square wave signals produced by the Signal Chopper, and the following Buffer corrects for other sensor nonlinearities. The signal then passes to the 1st Attenuator which, together with the 2nd Attenuator, controls the gain of the stage in 10dB steps. The 2nd and 3rd Amplifiers provide the rest of the required gain, and the 4th Amplifier together with the Gain D-A provides fine adjustment of the ac gain.

The Phase Synchronous Detector is then used to demodulate the ac signal. Timing signals for the Signal Chopper, Spike Blanking, and the Detector are provided by the Timing Logic circuitry. The recovered dc signal passes to the Peaking Meter, and through a switch to the comparator.

The microprocessor (μP) runs the program stored in read only memory. Data storage is achieved by using a battery backed, non-volatile RAM (Random Access Memory) chip. Outputs from the microprocessor drive the zero D-A, the 14-bit D-A, the gain D-A, the recorder D-A, the attenuator drives, the liquid crystal display (LCD), the GPIB interface, and the power reference. Inputs to the microprocessor are from the comparator, the keyboard, and the GPIB interface.

## 5.2 ANALOG PC BOARD DESCRIPTION

[Refer to Schematic Diagram (SD) AA01 on page 8-3.]

### 5.2.1 First Amplifier

(See Figure 5-2, below, and Sheet 1 of the SD)

IC1 and associated components are used for the second section of the 1st Amplifier. (The first section is located in the power sensor assembly.) When used with the 8531X series of sensors, this amplifier will have a gain of approximately 1000. Figure 5-2 shows a simplified diagram of the complete amplifier.

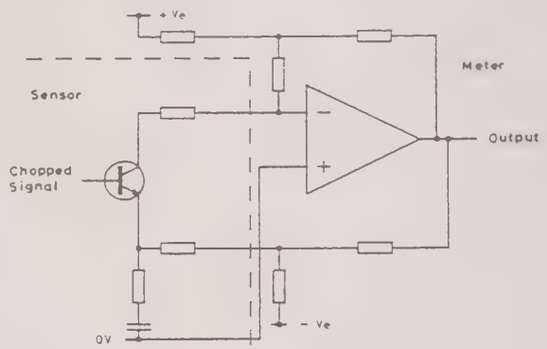


*Figure 5-2. First Amplifier Simplified Diagram*

AC gain is controlled by the components in the emitter circuit of the transistor located in the power sensor. DC bias for the transistor is set by R1 through R5. C2, C6, and C9 control the high frequency response, and the capacitor located in the power sensor controls the low frequency response. The amplifier has a band-pass characteristic centered at a chopping frequency of 925Hz.

IC2, R10, R11, and TR1 form a very low offset source follower which provides an earth reference from the signal ground in the power sensor. This earth reference, indicated by 0VA, is used by the rest of the ac gain stages. D1, D2, and R9 ensure that the earth reference varies only a slight amount (about 0.5V) when no sensor is connected to the instrument.

### 5.2.2 Spike Blanking

The spike blanking circuit consists of R114, C16, and IC3c. Its purpose is to remove noise spikes that can be present on the leading and trailing edges of the chopped dc signal coming from the power sensor (see Figure 5-3, below). IC3c and C16 act as a sample and hold circuit. The hold period starts at the time the signal chopper changes state, and lasts for a period of 180μs. R114 reduces errors caused by the hold time interfering with large signal levels at high RF power levels.

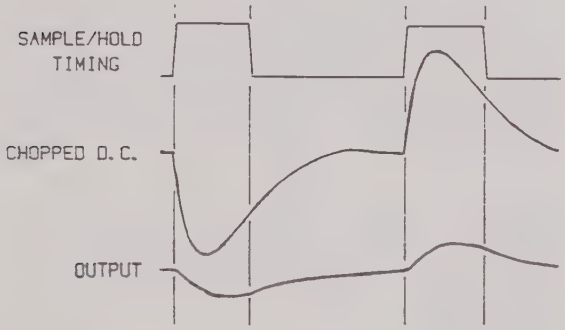


*Figure 5-3. Spike Blanking*

### 5.2.3 First Attenuator

Precision resistors R14 and R15 with IC3ab form a switchable, divide by 100 attenuator which is used whenever range changing takes place (see Table 5-A, below). Note that although there are 10 ranges available, only 5 attenuator ranges are required. C23 is used with R14 and R15 to provide a high-pass filter for bandwidth control.

*Table 5-A. Attenuator Control*

| Range | Total attenuation | Attenuator switches IC3a | IC3b | IC10a | IC10b | IC10c |
|---|---|---|---|---|---|---|
| 1 | None | ON | OFF | ON | OFF | OFF |
| 2 | 1/10 | ON | OFF | OFF | ON | OFF |
| 3 | 1/100 | OFF | ON | ON | OFF | OFF |
| 4 | 1/1000 | OFF | ON | OFF | ON | OFF |
| 5 | 1/10000 | OFF | ON | OFF | OFF | ON |

### 5.2.4 Second Amplifier

The second amplifier consists of IC4a with feedback components R22 and R23. The gain is approximately 25. C35 is used to control the high frequency roll off.

### 5.2.5 Second Attenuator

IC10 together with R24, R25, and R26 are used to form the second attenuator. The principle of operation is the same as described in Section 5.2.3 with the exception that this attenuator also has a divide by 10 setting.

### 5.2.6 Third Amplifier

The third amplifier has a gain of about 35. R30 and R31 control the gain of IC11a, and C38 controls the high frequency roll off.

### 5.2.7 Fourth Amplifier

The fourth amplifier is different from the other amplifier stages in that its gain can be very precisely controlled. It is basically a standard gain stage (composed of IC11b, R37, and R38), but it also has both inverting and non-inverting inputs. The main signal is applied to the non-inverting input which has a gain of approximately 3. The gain of the amplifier is reduced when a signal from the gain D-A (which uses the main signal as its reference) is applied to R37 and the inverting input. This allows the gain to be finally controlled over the range 1 to 3.

### 5.2.8 Phase Synchronous Detector

(Refer to Sheet 2 of SD AA01 on page 8-5)

The ac input signal is restored to dc by this circuit. Samples of the signal are taken on each half cycle by closing the switches IC14a and IC14d alternately. C49 and C50 charge up to the sample voltage during the time the switch is closed. These sample and hold capacitors must be able to charge and discharge rapidly to ensure a fast response to changes in the signal level. The time constant is determined by a combination of the effective impedance of the switch, the output of the fourth amplifier (IC11b), and the values of C49 and C50. This combination allows an almost complete sample to be taken within the sampling period.

When measurements are being taken on the most sensitive range (range 1), R53 and R54/R115 are placed in series with the coupling switches. These increase the charge time of the capacitors to form a very low frequency, low-pass filter.

IC15 is an instrumentation amplifier offering a high impedance to C49 and C50 in order to maintain their charge, and also allowing a shift of the earth reference to the 0V reference used throughout the dc stages. To eliminate linearity errors, precision resistors R34, R35, R36, and R42 ensure that the gain on each input will be the same.

The output from IC15b is then fed to the peaking meter via R78, and to the comparator (IC17) via IC16b. This signal is also used for the levelling output after going through the low-pass filters, R58 and C60, and buffer IC18b.

### 5.2.9 Comparator and A-D Conversion

The comparator output is applied to the Serial Input Data (SID) pin of the processor. The inverting input is driven from the 14-bit D-A. The non-inverting input is driven from either the phase-synchronous detector or the Zener diode located in the power sensor housing. This arrangement allows the processor to make successive approximation analog-to-digital conversions. To do this the processor sets the most significant bit of the 14-bit A-D, and then reads the SID to check the output of the comparator. If the output of the comparator is high, the data is kept. If not, the bit is set to reset. The processor continues by setting each bit in turn, deciding whether to keep or discard each one, until all 14 bits have been checked.

### 5.2.10 Power Sensor Zener Diode Drive

The Zener diode located in the power sensor assembly is used to tell the 8531 which type of sensor is being used. The diode is driven from a 5mA constant current circuit consisting of R77, R116, D10, D11, and TR14. The voltage from the diode is scaled by R112 and R113 before being applied to the comparator.

The type of sensor being used will define the required scaling and linearity corrections that must be applied to be sure that a true power reading is taken. Table 5-B shows the various diode voltages that are used, with the appropriate scaling and corrections that are applied.

*Table 5-B. Power Sensor Zener Diode Voltages*

| Zener voltage | Sensor Type No. | Sensor top power | Thermo-electric sensor linearity correction | Diode sensor linearity correction |
|---|---|---|---|---|
| 2.7 | 85320 | 10 µW | NO | YES |
| 3.3 | - | 10 µW | NO | NO |
| 3.9 | Spare | - | - | - |
| 4.7 | - | 30 mW | NO | NO |
| 5.6 | 85310 | 100 mW | YES | NO |
| 6.9 | 85312 | 100 mW | YES | NO |
| 9.2 | - | 10 W | YES | NO |
| 10.0 | - | 100 W | YES | NO |

### 5.2.11 Timing Logic

(Refer to Sheet 1 of SD AA01 on page 8-3)

ICs 5 through 9 and their associated components provide all of the timing signals for the 8531. Outputs from these circuits drive the signal chopper in the power sensor, the spike blanking, and the phase synchronous detector. The basic frequency of operation is 925Hz.

The master oscillator is IC5 which is a gated astable (4047) set permanently on by its input control lines. IC5 has three outputs; pin 13 is at twice the 925Hz chop rate, and pins 10 and 11 provide complementing 925Hz square waves.

The output from IC5, pin 13, drives IC6 which is configured as a monostable with a period of 180µs. The timing components of IC6 are R18, R55, and C24. The output from IC6 supplies the sample/hold timing for the spike blanking switch, IC3c.

The output from IC5, pin 13, also drives the input of one half of IC7, a precision dual monostable. The first monostable provides the delay before the sample pulse required by the phase synchronous detector. This then drives the second monostable to generate sample pulses on each half cycle of the chopped waveform. Two NAND gates, part of IC8, are used to direct the pulses to the correct sample switch in the detector.

Both of the 925Hz signals from IC5 are used to derive the chopper drive signals for the power sensor. Both signals are delayed at the input of IC9, a dual D-type bistable, by the action of R27, C32, and R28, C33. Outputs at pins 1 and 13 are out of phase. The signal output from pin 13 is of a slightly longer duration than that from pin 1, and leads the signal from pin 1 by a fractional amount. The difference in phase relationship ensures the correct on/off se-

quence of operation by the signal chopper FET. Figure 5-4, below, shows the relationships of the timing signals.

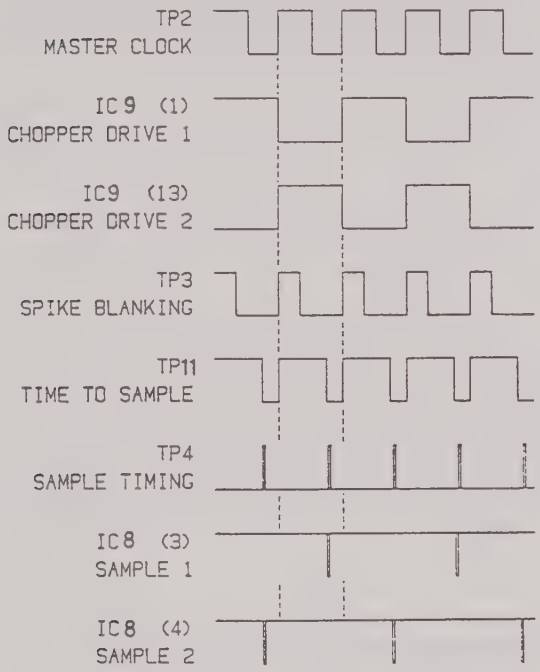


*Figure 5-4. Overall Timing Signal Relationships*

### 5.2.12 D-A Converters

(Refer to Sheet 2 of SD AA01 on page 8-5)

The 14-bit D-A (IC21) is a CMOS multiplying digital-to-analog converter. Its digital inputs are generated on the Processor PC board, AA02. It works in conjunction with operational amplifiers IC22 and IC23 to give a bipolar output of approximately ±6.2V. R72 and R76 adjust any offsets generated by the operational amplifiers, and R70 adjusts the center point of the D-A output.

The -6.2V required by the D-A circuitry is produced by D13, an ultra-stable Zener diode. The diode is driven from a 7.5mA constant current source consisting of R74, R75, D14, and TR6.

### 5.2.13 Serial D-A Function

The Gain D-A (Sheet 1 of the SD), and the Zero and Recorder D-As (both on Sheet 2) are all based on the same type of multiplying D-A converter, the AD 7543. This special device is unique in that it has data loaded into it serially (see Figure 5-5). The DAC's logic circuitry consists of a 12-bit serial-in, parallel-out shift register and a 12-bit DAC input register. Serial data at the SR1 pin is clocked into the shift register on the trailing edge of STB3. Once the shift register is full, its contents are loaded into the DAC input register by sending LD1 low. These control signals are derived from the Processor PC board, AA02.

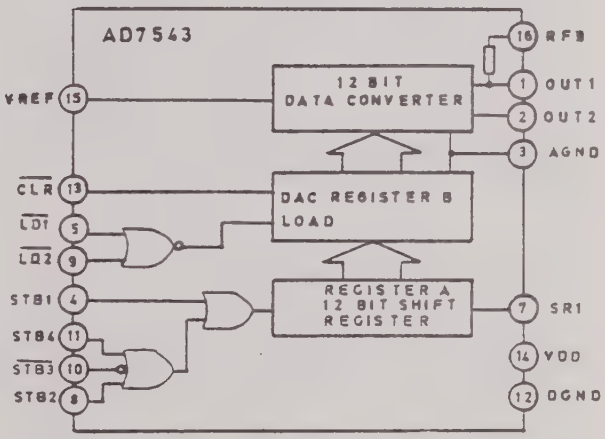


*Figure 5-5. Serial D-A Converter Diagram*

The Gain D-A is arranged for unipolar output using IC13. See Section 5.2.7, Fourth Amplifier, on page 5-5 for more details on how this D-A is used.

The Zero D-A circuitry provides a small voltage which is sent to the sensor to null out any offsets generated by the signal chopper. D-As IC19 and IC20a provide a unipolar 0 to +6.2V output. This is fed to operational amplifier IC20b which also has a -6.2V reference input. This causes a -3.1V to +3.1V to be produced from IC20b, pin 7, which is then scaled down by R67 and R68 before going to the sensor. The -6.2V reference for IC19 and amplifer 20b is generated by a low drift Zener diode, D12.

The Recorder D-A provides a 0 to +10V output to drive external X-Y recorders. The -10V reference voltage needed to do this is generated from the ultra-stable -6.2V reference, D13. The voltage is amplified to -10V by IC18a and associated components. R82 provides the ability to null out any offset on IC25 (part of the D-A circuitry).

### 5.2.14 Power Supplies

(See Sheet 3 of SD AA01 on page 8-7)

The circuits of the 8531 require four basic dc power supplies with which to operate. These consist of positive and negative 15V supplies which are used by all of the amplifiers, a 5V low current supply for the timing circuitry, and a high current 5V for the processor and GPIB boards. The design configuration of these supplies breaks down into three general sections. These include a raw dc supply, switching regulators and, in all cases except for the high current 5V supply, linear regulators.

The raw dc supply is produced by mains transformer T1, bridge rectifier D15, and reservoir capacitor C82. The primary circuit of T1 is switched to be able to accomodate ac mains inputs of 115V and 230V. The raw dc supply voltage can vary from about 10 to 20 volts depending upon the actual ac mains supply voltage.

The +15V and -15V supplys are derived from a step-up switching regulator that is set for approximately 20V out, followed by linear regulators which output 15V. This ensures clean dc voltages to drive the amplifier stages.

Referring to Figure 5-6, the switching step-up regulator operates as follows. When the switch closes, the supplied voltage (Va) drops to almost zero (Va - Vs) and the voltage Vin - Vs is applied across the inductor causing the inductor current to increase linearly. Because the applied voltage is less than the output voltage, the diode is reverse biased and current cannot flow to the output. Again, when the switch opens, the inductor current cannot change instantly and the applied voltage changes to the total of the output voltage plus the diode voltage. At this time current can flow through the diode to the load capacitor, and the inductor current decreases at a linear rate which is determined by Vout - Vd - Vin. Timing adjustments control the average diode current (Id) so that it is equal to the load current. If the load current is less than the maximum output current, off time is increased by a dead time with no current to the output. Input current can flow during both on and off times, so the average input current is always greater than the output current.

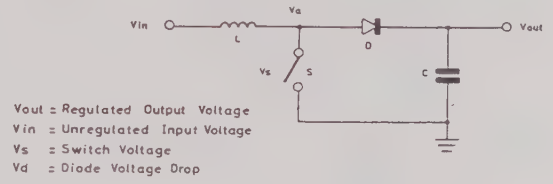


*Figure 5-6. Step-Up Voltage Regulator*

IC26 contains most of the components required for the regulator. The switched dc is also used to provide a simple negative supply. C85 ac couples the switching power to dc restoration diode D17. D18 then rectifies it, with C86 providing the output capacitance.

The positive and negative outputs from the switching regulator are filtered by L2, L3, C87, and C88 before being applied to the inputs of the linear regulators. IC27 is the +25V terminal regulator, and IC28 is the -15V regulator. C89 and C90 decouple the outputs of IC27 and IC28 to reduce noise and possible oscillations. D32 through D35 protect the regulators if any of them should fail.

The low current +5V is used by the timing logic. This is derived from the +15V supply by series resistor R89 and Zener diode D19.

The high current +5V is used by the processor board, AA02, the display board, AB01, and the GPIB board. The regulator is a step-down switchmode type, discussed in the next paragraph.

Referring to Figure 5-7, the step-down switchmode regulator operates as follows. When switch S closes, the voltage Va rises close to Vin (Vin - Vs), and the voltage Va - Vout is applied across the inductor causing the current to rise from zero. This current flows from the switch through the inductor and into the load and output capacitor. When the instantaneous inductor current iL is less than the load current, the capacitor provides the extra current and Vout

decreases slightly. When iL exceeds the output current the remaining current flows into the capacitor, increasing Vout, and continues increasing until the switch is turned off. At this point, since the inductor current cannot change instantly, Va falls to -Vd so diode D can turn on and provide the inductor current. The voltage across the inductor is now -(Vout - Vin) causing the change in the inductor current to be negative. The inductor current contines to fall toward zero until S turns on again and the cycle is repeated. The components in the system control the on/off cycle of S so that the average inductor current equals the output current, the average capacitor current will be zero, and Vout will remain constant.

IC29 controls the +5V regulator. Transistors TR7 and TR8 level shift and amplify the output from IC29 to drive MOS FET TR10 which acts as the switch. TR9, D22, and C95 ensure that there is sufficient drive voltage available on the gate of TR10 to turn it on properly. L4 is the switched inductor, C98 the output capacitor, and D23 the recovery diode. Voltage feedback is via R96 and R97, allowing the output voltage to be set correctly.

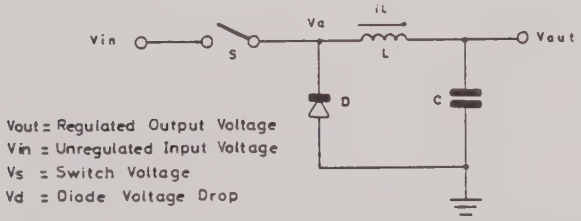


*Figure 5-7. Step-Down Voltage Regulator*

Additions to the basic supply provide over-current and over-voltage protection. R105 and R106 sense the current flowing into the inductor. When the voltage reaches approximately 0.6V, TR13 is turned on which, in turn, turns on thyristor D27. This removes the gate drive from switch TR10. D27 is held on by the current flowing through LED D29 and series resistor R110. When the output voltage exceeds 5.6V, D30 starts to conduct and will activate thyristor D31 when enough current is flowing through D30. When D31 is turned on, a very high current is drawn from the supply and the current limiting circuit will become operative.

### 5.2.15 Power Reference

(Refer to SD AC04 on page 8-17)

The power reference supplies a clean 50MHz carrier levelled at 1.00mW. The reference oscillator is enabled by a digital control signal applied to the transistor switches TR1 and TR2. Applying 0V turns TR1 off, thus turning TR2 on and enabling the power reference. When a positive voltage greater than 1.5V is applied to R1, TR1 turns on, turning TR2 and the power reference off.

TR3 and associated components form a modified Hartley oscillator that can be level controlled by the second gate of TR10. Output is coupled from the source of TR3 by C8 to the matching and harmonic rejection circuit consisting of C10, C11, C12, and L3. The matching circuit then feeds detector D2 and dc blocking capacitor C18. As the source impedance of a levelled circuit is 0 ohms, a 50 ohm source resistor is required. This is combined with a 2dB attenuator at R11. R12 and R13 form the rest of the attenuator which then sends RF power to the output.

The output from the detector diode, D2, feeds one side of the levelling comparator, IC1a. The -6.2V reference input is buffered by IC1b, with the gain set by R15, R16, R18, and R19. The resulting reference voltage is fed via D3, is used to provide temperature compensation for D2, and goes to the non-inverting input of IC1a. The output of IC1a drives the level control gate of the oscillator transistor, TR3.

### 5.2.16 Processor PC Board

(Refer to SD AA02 on page 8-11)

The processor PC board contains a type 8085AH-2 CPU (Central Processing Unit), buffers for the address and data lines, address decoding, EPROM, non-volatile RAM, programmable peripheral interfaces (PPIs), and reset circuitry. Components and their interconnections are briefly described in the following paragraphs. Full descriptions of the 8085 CPU and 8255 PPIs can be found in the "MCS85 Users Manual" published by Intel Corporation. The purpose of the CPU is to control the instrument through address and data buses. The program to accomplish this control is contained in the EPROM, and data is stored in the non-volatile RAM. The

CPU is an 8-bit NMOS microprocessor with interrupts, and contains a multiplexed address/data bus.

The CPU, IC3, uses a 10MHz crystal for its clock generator. This is internally divided down to give a 5MHz operating frequency. At power-on, a reset is applied to IC3 pin 36. The reset instruction RESET IN, lasting for at least three full clock cycles, synchronizes with the internal clock and resets the following:

1. Program counter is cleared.
2. Instruction register is cleared.
3. Interrupts are disabled.
4. All tri-state bus lines are floated (ALE is not tri-state).

5.2.16.1 ADDRESS DECODING

The address and data lines of IC3 are multiplexed. Pins A8 through A15 are output-only lines carrying the high-order byte of memory addresses. AD0 through AD7 are bi-directional lines which output the low-order byte of memory addresses, and also double as a bi-directional data bus. The top four address lines, A12 through A15, are decoded by the IC7 decoder, pins 3 through 8, to give addressing blocks of 4k in the bottom half of the memory map.

5.2.16.2 WAIT STATES

The operation of the CPU includes read and write sequences called machine cycles. These can contain from three to six clock cycles (or T states), with the instruction fetch MC1 containing a minimum of four T states and the remainder containing three (see Figure 5-8). A memory read must occur within three clock periods because IC3 needs this time to place the input into the instruction register.

Slower input/output devices require more time to respond which makes it necessary to delay the input to the instruction register. Provision for this is made by the CPU's ability to generate a function called "Wait Clock Periods". The READY signal line is sampled by the CPU at the clock period T2. If this signal is at a logical low, a Wait Clock Period will follow. Further Wait Clock Periods would then be generated until the READY signal is asserted high. One Wait Clock Period is required by the 8531; the clock periods and signals generated in the first machine cycle are show in Figure 5-9. IC6 and IC10c&d circuitry holds the READY line low for one count, then a high is asserted and the next clock period (T3) will start.

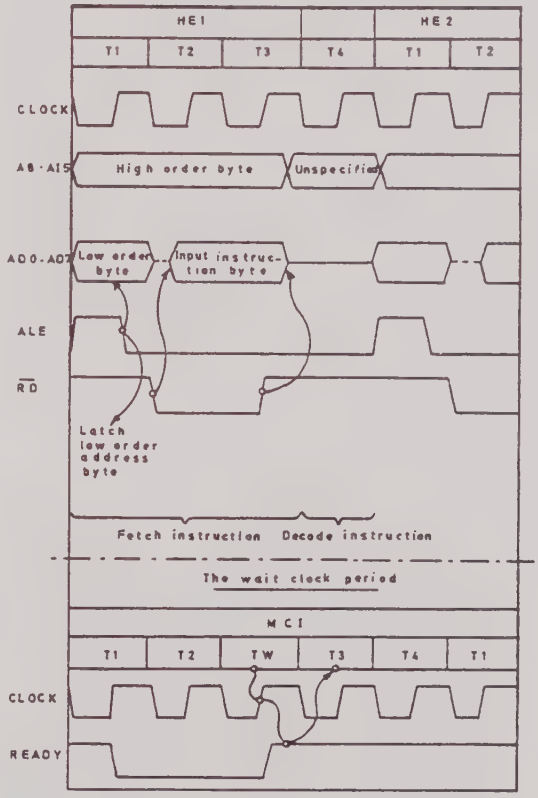


*Figure 5-8. CPU Timing: Wait State & Fetch Instruction*

Because only Wait states are required by PPIs IC12 and IC13, the Wait clock period is generated only when address line A14 goes high (i.e. for addresses in the range 4000H to 7FFFH).

| ADDRESS HEXADECIMAL | | ADDRESS LINES | | | | SELECTED IC |
|---|---|---|---|---|---|---|
| | | A15 | A14 | A13 | A12 | |
| 8000H | - | 0 | 1 | 1 | 1 | SPACE |
| 7000H | PPI 2 (3 LOCATIONS) | 0 | 1 | 1 | 0 | IC12 |
| 6000H | PPI 1 (3 LOCATIONS) | 0 | 1 | 0 | 1 | IC13 |
| 5000H | GPIB SWITCH (1 LOCATION) | 0 | 1 | 0 | 0 | AA11 IC7 |
| 4000H | GPIB CONTROLLER (8 LOCATIONS) | 0 | 0 | 1 | 1 | AA11 IC1 |
| 3000H<br>27FFH | ↑ DATA AREA +(RAM) | 0 | 0 | 1 | 0 | IC9 |
| 2000H | ↑ OPERATING | 0 | 0 | 0 | 1 | IC8 |
| 1000H | PROGRAM ↓ | 0 | 0 | 0 | 0 | IC8 |
| 0000H | | | | | | |

*Figure 5-9. Memory Decoding*

5.2.16.3 ADDRESS AND DATA BUFFERING FUNCTIONS

The IC4 address buffer is an octal tranparent latch, and demultiplexes the low-order address and data lines using the ALE (Address Latch Enable) signal. Timing requirements cause some noise spikes on the latched address output lines. These are caused during the transition from data to address, and are to be expected.

The IC5 data buffer is an octal bus transceiver, and buffers data to and from the data bus lines (D0 through D7). The direction of the transceiver is controlled by the read (RD) signal from the CPU. Data is sent to the CPU when the RD line is at logical low.

5.2.16.4 EPROM FUNCTIONS

The instrument operating program is contained in IC8, an ultraviolet erasable PROM. It is an 8k x 8-bit device.

The EPROM is accessed when its CE enable line is at a logical low. The outputs remain tri-state until the output enable line, OE, goes low. At this time, the data from the location in the EPROM that has been specified by the state of address lines A0 through A12 is placed in the data bus. Figure 5-9 shows the decoding function for the EPROM and other devices in relation to the hexadecimal address locations.

5.2.16.5 RAM FUNCTIONS

The random access memory is a 2k x 8-bit CMOS device. This allows a small battery to provide standby power to make the RAM non-volatile. The select line from decoder IC7 is inverted by IC10b before being NANDed with the CPU reset line. The NAND gate is formed by components D6 through D9, R17, R18, and TR2. The output from the TR2 collector drives IC9, line CS. When the 8531 is powered down, TR2 is turned off by the reset circuitry ensuring that no locations of the RAM can be written to if the +5V supply fails.

The direction of data to and from IC9 is controlled by the output enable, OE, and write enable, WE, control lines. When WE is at a logical high and OE is low, data is output from the RAM to the data bus. If OE is high and WE is low, data is written into the RAM.

When the 8531 is powered down, the standby power for IC9 comes from lithium battery B1. The battery is isolated from the +5V power supply by special diodes D10 and D11. D10 has extremely low reverse leakage so that no power can pass from the battery to the power supply. D11 has very low forward voltage so that the battery can be used until the voltage out is approximately 2V. The expected lifetime of the battery is between a minimum of 5 years to a maximum of 10 years.

5.2.16.6 RESET CONTROL

The reset control circuitry is used to inform the CPU of a power-down situation, and to ensure that the CPU itself powers down in an orderly fashion. Figure 5-10 on the next page shows a simplified diagram of the reset control circuit.

The TRAP line, a non-maskable interrupt, is used to inform the CPU of an impending loss of power. When this interrupt occurs, the CPU stores the current front panel settings in STORE 0 so that they can be recalled at power-up. When the RESET IN line on the CPU becomes logically low, the CPU halts any processing and sends all outputs to a tri-state mode.

The first half of the dual re-triggerable device, IC1, is triggered by ac derived from the secondary winding of the mains transformer. This causes the monostable to remain triggered until the voltage from the ac mains supply has been removed. The pulse duration of IC1, part 1, is set to 27ms so that supply frequencies as low as 45Hz can be used. When IC1 is no longer being triggered, Q1's low output goes high which raises the TRAP interrupt. At the same time, Q1's high goes low which sets the RESET IN line of the CPU low 4.5ms later. During this time, the settings are stored in the RAM. The 4.5ms delay is generated by delay network R5 and C3. The Q1 low is NANDed together with the CPU RESET IN line by IC2a. The output from the NAND gate is fed via D3 to the clear input, C1, of the monostable. This ensures that the monostable remains in the same state even if the mains supply voltage is again applied. Voltage potential divider R22 and R23 also ensure that the monostable stays un-triggered until the +5V supply has reached an operable level.

Pressing the front panel RESET key activates the second monostable after a 200ms delay fixed by R7 and C5. This monostable has a duration of 180ms. The Q2 low is applied to the clear input (C1 low) of the first monostable. This means that pressing the RESET key has the same function as turning the supply off, but allows the CPU to be reset without removing any supplies which ensures the stability of the 8531's amplifiers and other circuit functions.

The dual monostable and the NAND gates IC1 and IC2 are supplied with power via D4 and storage capacitor C4. This ensures that the CPU TRAP and RESET IN lines remain steady until all power has been removed from the rest of the processor board circuits.

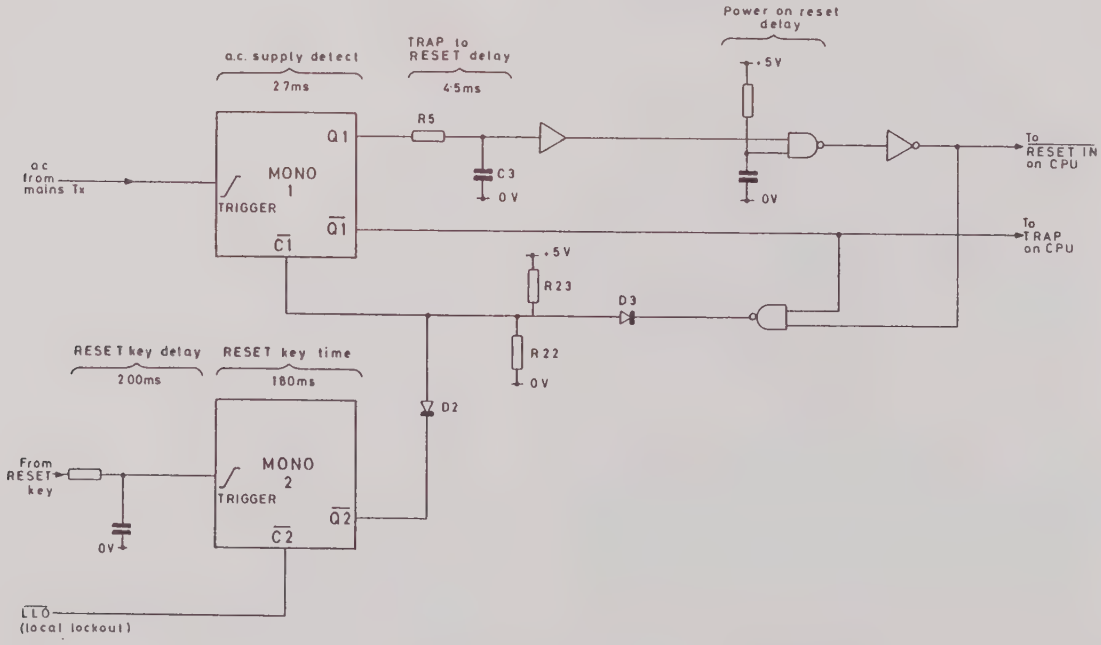


*Figure 5-10. Simplified Reset Control Circuit*

### 5.2.17 PPI FUNCTIONS

IC12 and IC13 are general purpose Programmable Peripheral Interface (PPI) type 8266 components. Each has 24 I/O pins which can be individually programmed in two or three groups. There are three major modes of operation, but only one is used. For more information on the 8255, see Intel Corporation's publication "MCS-85 Users Manual". In the operating mode that is used, the I/O pins are divided into groups of 8 that can be used as either input or output ports. Table 5-C shows how the groups are allocated, and the circuits to which each are assigned.

*Table 5-C. PPI Port Allocations*

| PPI | Port | In or Out | Bit | Controls or Reads |
|---|---|---|---|---|
| 1 IC13 | A | Input | 0 | Key 4 |
| | | | 1 | Key 5 |
| | | | 2 | Key 6 |
| | | | 3 | Key 7 |
| | | | 4 | Key 8 |
| | | | 5 | Key 9 |
| | | | 6 | Key DP |
| | | | 7 | Key ENT |
| | B | Input | 0 | Spare Keyboard AB01 |
| | | | 1 | Spare |
| | | | 2 | Spare |
| | | | 3 | Key - (Minus) |
| | | | 4 | Key 0 |
| | | | 5 | Key 1 |
| | | | 6 | Key 2 |
| | | | 7 | Key 3 |
| | C | Output | 0 | Serial D-A and DISPLAY STROBE LINES |
| | | | 1 | CAL D-A LOAD |
| | | | 2 | ZERO D-A LOAD |
| | | | 3 | RECORDER D-A LOAD |
| | | | 4 | DISPLAY DRIVER LOAD |
| | | | 5 | POWER REFERENCE ON/OFF |
| | | | 6 | REAR PANEL BLANKING OUTPUT |
| | | | 7 | LOCAL LOCKOUT TO RESET CONTROL |
| 2 IC12 | A | Output | 0 | 14-BIT D-A LEAST SIGNIFICANT BIT |
| | | | 1 | |
| | | | 2 | |
| | | | 3 | |
| | | | 4 | |
| | | | 5 | |
| | | | 6 | |
| | | | 7 | |
| | B | Output | 0 | |
| | | | 1 | |
| | | | 2 | |
| | | | 3 | |
| | | | 4 | |
| | | | 5 | 14-BIT D-A MOST SIGNIFICANT BIT |
| | | | 6 | SOURCE 1 ) CONTROL WHICH OF SIGNAL OR |
| | | | 7 | SOURCE 2 ) HEAD ZENER TO BE MEASURED |
| | C | Output | 0 | GAIN CONTROL A |
| | | | 1 | GAIN CONTROL B |
| | | | 2 | GAIN CONTROL C |
| | | | 3 | GAIN CONTROL D |
| | | | 4 | GAIN CONTROL E |
| | | | 5 | SPACE |
| | | | 6 | FILTER CONTROL 1 |
| | | | 7 | FILTER CONTROL 2 |

### 5.2.18 KEYBOARD AND DISPLAY PC BOARD FUNCTIONS

(Refer to SD AB01 on page 8-15)

The functions of the various components located on this PC board can be divided into two distinct parts. These include the purpose of the key switches and the operation of the display drivers.

The LCD display drivers IC1 and IC2 are serial input devices, and have only three control lines but provide up to 32 segment drives from each IC component. The serial data is clocked in by a falling edge on the CLX input line. This data is then loaded to the display drive by a logical high on the LOAD signal line. The two ICs are cascaded so that three lines control both IC1 and IC2.

### 5.2.19 GPIB INTERFACE MODULE

(Refer to GPIB Circuit Diagram on page 8-14)

This module is equipped only when the Model 8531-01 (option 01) instrument has been specified, or when the user has installed the module after ordering WMI P/N 19947 (GPIB Module). Its purpose is to allow remote control of the instrument through the GPIB by a remote controller/calculator. The full specifications of IEEE-488 1978 are implemented (no control function).

The type 8291 GPIB talker/listener integrated circuit, IC1, is interfaced with the microprocessor in the 8531 to provide both talk and listen capabilities. The IC2 through IC5 transceivers are used to translate the negative true logic and act as drivers. IC6c&d provide the logic low level for the receive instructions T/R1 to IC4, pins 7 and 9, or the talker high level for IC2, IC3, and IC4. and also provides the additional buffering necessary for the three ICs in line. Also part of the interface module are the GPIB bus terminator loads, R1 through R6, the address switch SW1, and its buffer IC7.

The function of the board is to provide buffering between the GPIB and the 8291 GPIB handler. The external controller directs the flow of data on the bus, and designates when the 8531 is to send data and when it must receive it. The bus uses 16 signal lines to connect all of the units in the test system in parallel. These lines are sub-divided into data transfer

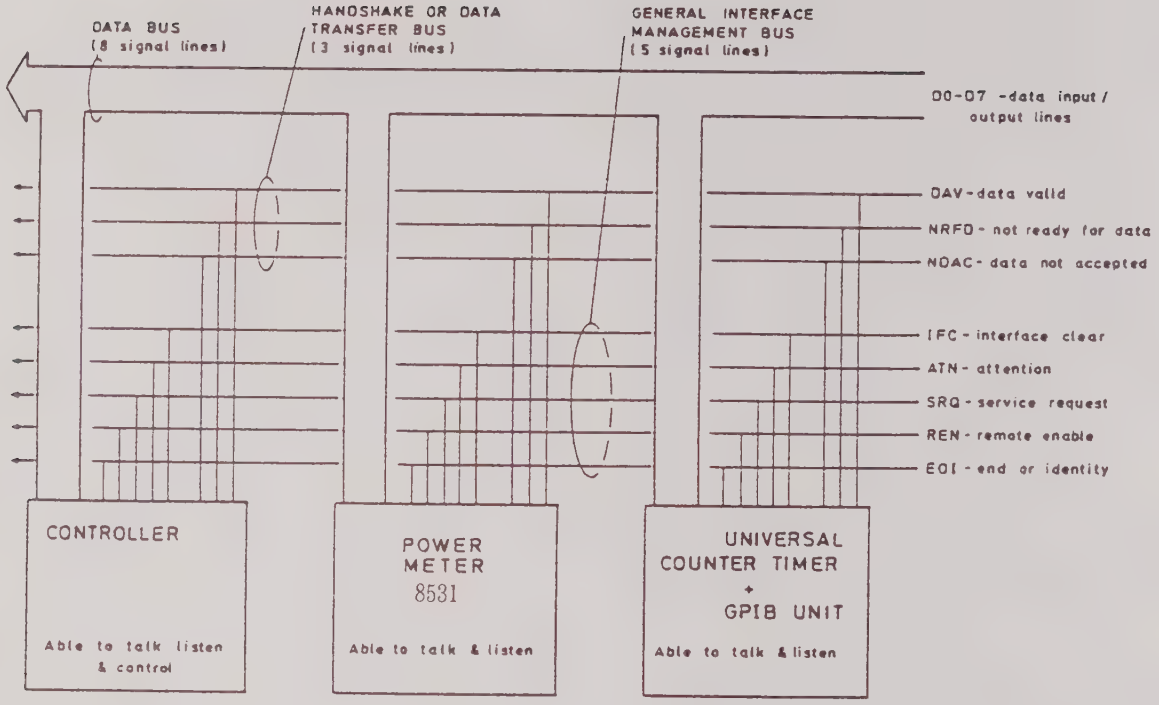


*Figure 5-11. GPIB Interface Bus Structure*

and interface management buses as shown in Figure 5-11.

5.2.19.1 DATA BUS FUNCTION

The data bus is composed of 8 data input/output lines (D0 through D7), and is used to transfer any data (commands, addresses, and instructions) in bit parallel, byte serial format.

5.2.19.2 INTERFACE MANAGEMENT BUS FUNCTIONS

This bus is used to manage the orderly flow of data across the interface. It consists of five lines that convey the following commands or information sent either by the controller or the instrument:

1. Interface Clear (IFC):

Sent by the GPIB controller to clear all device interfaces so that they are set to an initial, power-on condition.

2. Remote Enable (REN):

This command is sent by the controller to enable the instruments on the bus to be placed under remote control.

3. Attention (ATN):

Sent by the controller to indicate that an address or command is on the data lines.

4. End or Indentify (EOI):

This is either an instrument or controller signal sent to indicate the end of a message.

5. Service Request (SRQ):

Sent by the controller to an instrument to indicate that it (the controller) needs service. This can be programmed using the 'SQ' program code (see Section 4.3.6.17 on page 4-5 of the IEEE Interface Section of this manual).

5.2.19.3 HANDSHAKE OR DATA TRANSFER BUS

This bus coordinates the flow of data. It is comprised of three lines which are used for the handshaking process by which a talker or controller synchronizes its readiness to send data with a listener's readiness to receive data. The handshake signals are:

1. Not Ready for Data (NRFD):

This signal is asserted (low) by a listener when the listener is active and not yet ready to receive data. The signal is set high when the listener is ready to receive data. The DAV indication (below) can then be signalled if further data is to be processed.

2. Data Valid (DAV):

DAV is asserted by a talker to indicate that the data it has placed on the bus has settled and can be accepted.

3. Not Data Accepted (NDAC):

This signal is asserted by a listener when receiving information from the data lines. Release of the NDAC line tells the data source that new data can be submitted.

5.2.19.4 BUS OPERATION

1. A series of messages can be sent by the controller asserting IFC on the management bus to set the interface to an initial condition.

2. The controller then establishes which instruments are to be listeners by asserting ATN, and handshaking the individual listen address of each instrument over the bus. Similarly, the controller designates the talker (only one instrument can talk at a time) by sending its talk address, again with ATN asserted.

3. When ATN is removed, the talker is then able to place data on the data lines D0 through D7. The transfer of this is controlled by the handshake process, and is received by all addressed listeners. The talker typically concludes the sequence by asserting EOI, and the controller then resumes control.

4. Both the talker and the listener can be switched by the controller into an inactive state by asserting IFC, or by sending OTA (Other Talk Address) and UNL (Unlisten) on the data bus.

5.2.19.5 HANDSHAKE PROCEDURE

(See Figure 5-12 on page 5-16 for a typical handshake cycle)

The handshake is used whenever data is transferred on the bus. When a signal is asserted, the function indicated by the line is carried out (e.g. NRFD is asserted to signify that the listener is not ready to receive data, and unasserted or removed when the listener is ready to receive data). A typical handshake would take place as follows:

1. Talker (controller) places a byte on the data bus with DAV initially unasserted to show data is not yet valid.

2. When all listeners are ready to receive data, NRFD is removed and NDAC asserted.

3. After a delay to allow the data bus to settle, the talker asserts DAV to show that the data is valid and can be accepted.

4. The data byte is transferred, and the listeners then assert NRFD. When all of the listeners have accepted the byte, NDAC is removed to signify receipt.

5. The talker removes DAV, listeners assert NDAC, and the bus reverts to its initial condition ready for the next data byte. A typical cycle is shown in Figure 5-12.

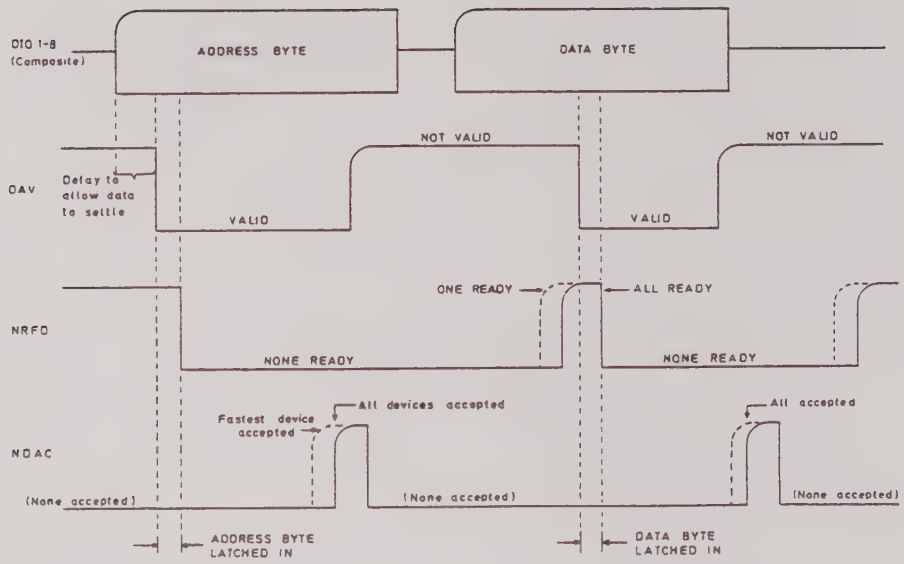


*Figure 5-12. Typical Handshake Cycle*

## 5.3 SOFTWARE DESCRIPTION

### 5.3.1 Software Program Initial Sequence

On initial power-up, the processor sets up a stack pointer at the highest working location in RAM, and initializes the 8255 PPIs. The display is then set to read "8531" while a simple test is made on all RAM locations. The TRAP interrupt is enabled at this point. A checksum byte stored on power-down is checked to ensure data retention. The D-As are then set as the data required. The program issue is then displayed in the form "1 5 n" for 1/2 second. At this point, if any key is pressed the program jumps to the calaid routines. The 8291 chip is initialized and the GPIB address is displayed if the chip is present.

### 5.3.2 Software Program Measuring Sequence

1. If the first measurement in a testing routine is being taken the range switches are set, the range offset is looked up, the range limits are looked up, and the settling time is calculated from the average number. The averaging sample number is then set to zero, a single A-D conversion is carried out and stored as the previous average, and the measurement counter is reset. If settling time is enabled, the status byte in the GPIB output string is set to an 'S', and the number of conversions required on the inside averaging loop is looked up if the routine is set for the fast operating mode (GPIB only). If no averaging figure has been entered, the default value of 400 is used.

2. The inside averaging loop checks to see if any key has been pressed. If so, the program jumps to the keyboard routines. An A-D conversion then takes place, and is averaged with the previously stored data. The loop is repeated until the required number of conversions have taken place.

3. The power sensor diode is then measured by performing an A-D conversion with the switches set to read the diode. The data from the conversion is then used to decide which diode is in use. Data regarding linearity correction and sensitivity are saved.

4. The measured power data is then compared with the range limits stored previously. The program jumps to the range error routine if the limits are exceeded, and an SRQ is raised if necessary.

5. The data is then converted into the binary floating point format required by the MATHS package. The range offset is added at the same time.

6. If the filter is in (Range 1), the data is corrected for the gain error of the filter.

7. The outside average (selectable from the front panel) is then performed.

8. A check on the sign of the data is carried out and if -ve and the dB mode is selected, UNDER-RANGE is flagged and the program jumps to the range error routine.

9. The data is then range corrected so that the top reading on the center range is 1.000.

10. Diode or thermocouple linearity correction is then applied as required.

11. CAL FACTOR correction is then applied.

12. The RECORDER output D-A is then set as required according to the following procedures:

    a) If in the linear mode (W), output is 0 to 5V for each range.

    b) If in the dB mode mode, output is +5V for the top of range 3 with a gain of 1.0V/10dB.

13. Duty cycle correction is then applied.

14. The resultant data is then changed to mW, if required, dependent upon the sensitivity of the sensor as indicated by the HEDTYP.

15. The data is then changed to dBm, and any dBRel offset added as required.

15. The attenuation offset is then applied if required.

16. The final routine in the main loop basically drives the display and GPIB output. It can be divided into three main functions:

    a) Round off the data reading according to the amount of averaging that is being applied. This is range dependent in the dB mode.

    b) The settling time is checked if enabled. If the settling time has been reached, a flag is set to indicate this.

    c) The measurement result is loaded into the GPIB buffer and also displayed.

17. If the routine is in the GPIB talk only mode, the GPIB buffer information is output to the GPIB.

18. An SRQ is raised if SRQ on end of measurement was specified.

19. If the routine is not in the HOLD mode (GPIB only), the program jumps back to the start of the main loop (description starting at the beginning of this section, Section 5.3.2 on page 5-16).

20. If the routine is in the HOLD mode, a check is made to see if local lockout is set. If not, the program performs a loop checking to see if the LOCAL key has been pressed. Otherwise it halt the processor.

# 6. PERFORMANCE VERIFICATION TESTS

## 6.1 INTRODUCTION

The tests listed in this section can be used for performing a quick check of the operation of the Model 8531 Power Meter. These tests can also be used for receiving inspection testing when the instrument is first received, if required.

Sections 2.2 and 2.3 of the Initial Instructions section of this manual should be reviewed to ensure that the instructions given therein have been complied with before the instrument is turned on. Prior to starting these tests, the instrument should be allowed to warm up for at least 10 minutes to assure maximum stability before testing.

If any of the results specified in these procedures cannot be obtained, refer to the pertinent section in the Maintenance section of this manual.

A Performance Verification Test Data recording sheet is located on page 6-5. This sheet should be removed, copied, and the copies used for recording test indications (as specified in the test procedure) each time a Performance Verification test is performed on this instrument.

### 6.1.1 Equipment Required

The only piece of test equipment required for these tests will be a signal generator. The generator should have a minimum specification of ±1dB at 50MHz. An example is the Wavetek Model 2500 OR 2520. An 8531X series or 85320 sensor will also be required.

## 6.2 TEST PROCEDURES

(If necessary, refer to the Operation section of this manual for assistance in accomplishing the following procedures.)

### 6.2.1 Power-On Performance Checks

The following checks will demonstrate that the instrument's measuring circuits are functioning when it is first turned on. If there are any problems encountered after initial power-on, one of the error codes shown in Table 6-A, below, will be displayed.

*Table 6-A. Error Codes*

| | |
|---|---|
| 01 | Power-On Fail |
| 02 | No RF Sensor |
| 03 | Auto-Zero Fail |
| 04 | Auto-Cal Fail |
| 05 | Manual Entry Error |
| 12 | Store/Recall Error |

#### 6.2.1.1 POWER-ON DISPLAY CHECK

When the unit is first turned on, the LCD display should show the software version number (e.g. "nn") and the GPIB address (if the GPIB option 01 is equipped). If no power sensor has been attached to the instrument yet, the LCD will also display the error code "Er 2". If a sensor has been attached and no RF power is being applied to it, the display will show either a very low power reading or five dashes ("-----") and the "under range" annunciator.

#### 6.2.1.2 AUTOZEROING CHECK

Press the ZERO key on the front panel. This should cause the LCD to display the five dashes mentioned above, and the "zero" annunciator. As each of the 8531's five ranges is zeroed, one of the dashes is blanked. When all of the dashes have been blanked, all ranges are zeroed. After zeroing, the instrument will return to the range previously set or, if no range was set, to auto-range. With no RF power applied, a low power reading or the five dashes and "under range" annunciator will again be displayed.

6.2.1.3 AUTOCALIBRATION CHECK

Press the LINEARITY FACTOR key on the front panel. From the bar chart located on the power sensor housing and labelled LIN F, enter the linearity factor. Press the CAL FACTOR key, and enter the 50MHz reference calibration factor given on the sensor. (For the 85310 and 85313 sensors the default figure of 100 applies, and no entry is required.)

Connecting an 8531X series sensor to the Power Reference output port on the front panel, and then pressing the CAL key, will cause the sensor to be calibrated to the 0dBm, 50MHz power reference signal generated within the instrument. When autocalibration is completed, the reference is switched off (if not previously selected). If the POWER REF key is pressed, the display should read 0dBm or 1.00mW if the autocalibration has been successful.

The Model 85320 sensor is calibrated to -30dBm, and the 0dBm reference signal should be applied to this sensor via the calibrated 30dB attenuator supplied with the unit.

### 6.2.2 Factory Pre-Set Adjustment and/or Test Checks

The procedures given in this section provide a check of the adjustments and/or tests that were made at the factory prior to the shipment of the instrument. The procedures will assure that the instrument has remained within the pertinent specifications given in Section 1.2 on page 1-1 of the General Information section of this manual.

6.2.2.1 ZERO SET/CARRYOVER

This test establishes that the instrument stays within the published accuracy specifications over its full dynamic range [full scale deflection (F.S.D..) for each range].

1. Press ZERO and wait until the function completes.
2. Set AVERAGE to 50, dB/mW to Watts.
3. Set RANGE to 1.
4. Wait 15 seconds for the averaging to be completed.
5. Record the zero error on the Test Data recording sheet on page 6-5.
6. Repeat Steps 3, 4, and 5 for Ranges 2 through 5.
7. All Zero Set/Carryover indications should be within the specified limit given on the Test Data sheet. If not, adjust per the instructions given in Section 7.3 starting on page 7-1 of the Maintenance section of this manual.

6.2.2.2 INSTRUMENTATION ACCURACY

This test checks that the instrument is within the published accuracy specifications for each of the measuring modes: Watts, dBm, and dBm Relative.

See NOTE 2 on the Test Data recording sheet on page 6-5 for special instructions regarding the computing of the dBm and dBm Relative mode errors.

1. Set the signal generator RF level to 0dBm (-30dB if an 85320 sensor is being used), and the carrier frequency to 50MHz.
2. With the signal generator set to OFF, connect the power sensor from the 8531 to the output of the generator. (Use the signal generator RF on/off control to switch the output on and off).
3. Press CAL FACTOR and enter the REFERENCE CAL FACTOR. (This figure is given on all sensors except the 85310 and 85313. For these sensors, the default CAL FACTOR of 100 is the correct value and no entry is normally required.)
4. Press ZERO and wait until the function completes.
5. Switch the signal generator RF output ON.
6. Press LINEARITY FACTOR, and enter the approximate linearity factor for the sensor being used.
7. Press CAL and wait until the function completes. This will be indicated by 0dBm (for the 85310) or -30dBm (for the 85320) being displayed on the unit's LCD display.
8. Set dB/mW to Watts, and AVERAGE to 50.

9. Set the RF level on the signal generator to -20dBm (for the 85310) or -60dBm (for the 85320).

10. Set RANGE to 1.

11. Wait 15 seconds for averaging to complete.

12. Record the reading in the Pa column of the Test Data sheet (on the "1/2" line).

13. Set RANGE to 2.

14. Wait 15 seconds.

15. Record the reading in the Pb column of the Test Data sheet.

16. The percentage of instrumentation error is computed by the formula: (Pa/Pb - 1) x 100.

17. Repeat Steps 9 through 15 for the rest of the power and range settings shown on the Test Data sheet.

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# PERFORMANCE VERIFICATION TEST DATA SHEET

NOTE: Copies should be made of this sheet before it is used, and kept with the manual. These copies can be utilized when future Performance Verification Testing is performed on this instrument.

Model 8531 Serial Number: _____

Date: _____

Operator: _____

Test Number: _____ (if required)

## SECTION 6.2.2.1 TEST RESULTS

| Range | 8531X Series Sensors | | | 85320 Sensor | | |
|---|---|---|---|---|---|---|
| | F.S.D. | Error Limits | Reading | F.S.D. | Error Limits | Reading |
| 1 | 10 μW | ±0.10mW | | 0.010nW | ±0.010nW | |
| 2 | 100 μW | ±0.13 μW | | 0.013nW | ±0.013nW | |
| 3 | 1mW | ±0.4 μW | | 0.04nW | ±0.04 μW | |
| 4 | 10mW | ±3.1 μW | | 0.31nW | ±0.31nW | |
| 5 | 100mW | ±30.1 μW | | 3.01nW | ±3.01nW | |

## SECTION 6.2.2.2 TEST RESULTS

| Initial/Final Range | Signal Generator Power Setting | | Pa | Pb | % Error | Error Limit |
|---|---|---|---|---|---|---|
| | 8531X Series | 85320 | (Watts) | (Watts | | |
| 1 / 2 | -20dBm | -60dBm | | | | See NOTE 1 |
| 2 / 3 | -10dBm | -50dBm | | | | 0.5% |
| 3 / 4 | 0dBm | -40dBm | | | | 0.5% |
| 4 / 5 | +10dBm | -30dBm | | | | 0.5% |

(See NOTE 2)

NOTE 1: When testing in low power ranges, the range errors will be effected by noise and zero set (each contributing a possible ±1%). To accurately measure the range error for ranges 1 and 2, the zero set values for both ranges should be deducted. This, however, is time consuming and susceptible to errors. Therefore, it is suggested that the instrumentation error for range 1/2 should be tested to 5% only, as a functional check.

NOTE 2: The test given in Section 6.2.2.2 can also be performed to check the instrument's accuracy in the dBm and dBm REL modes. When these modes are tested, the instrumentation error would be computed by Pb - Pa (dB). The specified maximum error in the dB modes is 0.02dB (except for range 1/2, test for 0.2dB only).

# 7. MAINTENANCE

## 7.1 INTRODUCTION

This section of the manual defines Model 8531 maintenance practices, calibration procedures, and troubleshooting checks that can be made for fault isolation down to specific circuit levels.

## 7.2 PERIODIC MAINTENANCE

The following maintenance procedures should be performed at least once a year unless the meter is operated in an extremely dirty or chemically contaminated environment, or is subject to severe abuse (such as being dropped). In such cases, more frequent maintenance (immediate, if the unit is dropped or severely abused in some way) is required.

A. Blow out all accumulated dust and dirt with forced air under moderate pressure.

B. Inspect the unit for any loose wires or damaged components. Check to see that the unit's PC boards are properly seated in their receptacles, and that all wire lead connectors are properly attached to their PC boards.

C. The front panel and housing of the unit can be cleaned using a cloth dampened in a mild detergent. Do not use abrasive cleaners, or any harsh chemicals. Wipe the soap residue off with a clean, damp cloth, then dry with a clean dry cloth.

D. Make a performance verification check in accordance with the procedures given in Section 5 of this manual. If the performance is within the required specifications, no further service is required.

## 7.3 CALIBRATION

Using all solid state components, the Model 8531 meter is extremely rugged and reliable. Consequently, there is very little drift due to component aging, and adjustments to the unit are rarely required. If measurements show that an adjustment is within the indicated range, do not attempt to set the adjustment "right on". It is often the case that variations in the equipment being used to make the test account for small differences in measured values. Since some adjustments can be interactive, **be absolutely sure that an adjustment is really required before making it.**

The adjustments listed in these procedures require the use of the calibration adjustment potentiometers and test points located on the top of the Analog PC board. To gain access to these components, the instrument's covers must be removed. This is done by unscrewing the two retaining screws in the rear panel feet, removing the feet and the diecast surrounding them, and then sliding the top and bottom covers to the rear and lifting them off. See Figure 7-1 on page 7-3 for the locations of the various components.

**A Calibration Data Recording Sheet covering the readings taken in Sections 7.3.3.2 through 7.3.8.1 is included on page 7-11 of this section. This sheet can be removed, copied, and the copies used for recording the readings taken whenever the calibration procedures specified in this section are performed on this instrument.**

(continued on page 7-2)





### 7.3.1 Internal Test Mode

To facilitate fault finding, the 8531 has a "TEST" mode which allows the outputs of the D/A converters, the filter, and the functioning of the display and keyboard to be checked.

To access the TEST mode, press any key and the RESET key simultaneously. **Keep the keys pressed until "tESt" appears on the display**, then release. Table 7-A shows the tests available.

To select the required test, press the appropriate key. To exit from a test (and from the TEST mode), press RESET.

NOTE: DO NOT GROUND ANY TEST POINTS.

*Table 7-A. TEST Mode Functions*

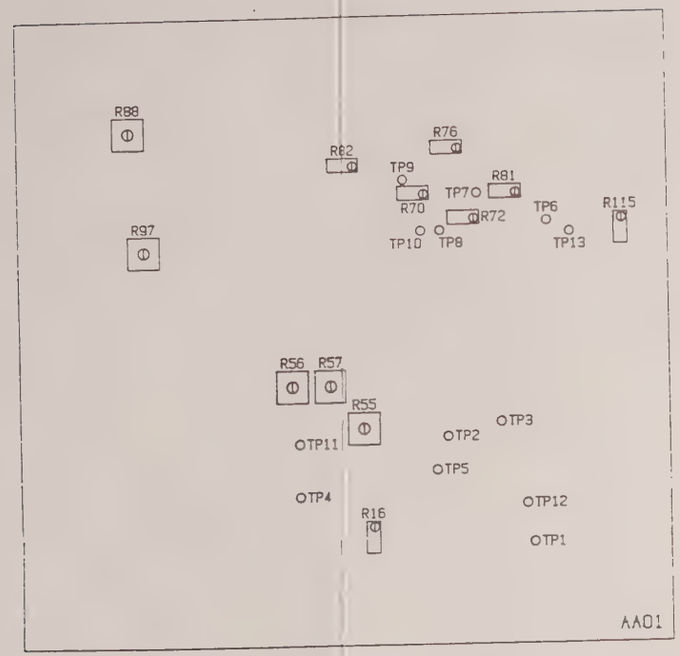
| Key | Test | Display | Test Point [1] |
|---|---|---|---|
| 0 | Display test and filter enable | All displays flash [2, 3] | TP6 wrt TP7 [4] |
| 1 | Recorder D/A to 0.000V | - - - - - - | Recorder O/P |
| 2 | Recorder D/A to 5.000V | - - - - - - | Recorder O/P |
| 3 | Recorder D/A to 9.9976V | - - - - - - | Recorder O/P |
| 4 | 14 bit D/A to Ref voltage (at TP8) | - - - - - - | TP10 wrt TP7 |
| 5 | 14 bit D/A to zero volts | - - - - - - | TP10 wrt TP7 |
| 6 | 14 bit D/A to -Vref x (8191/8192) volts | - - - - - - | TP10 wrt TP7 |
| 7 | Zero D/A to zero (no bits set) | - - - - - - | TP12 wrt TP1 |
| 8 | Zero D/A to center (MSB only set) | - - - - - - | TP12 wrt TP1 |
| 9 | Zero D/A to top (all bits set) | - - - - - - | TP12 wrt TP1 |
| . | Auto-Cal (gain) D/A to zero | - - - - - - | TP13 wrt TP1 |
| ENT | Auto-Cal (gain) D/A to top | - - - - - - | TP13 wrt TP1 |
| - | Keyboard Test | Display appropriate to key pressed | |

NOTE 1: The locations of the test points on the Analog board (together with the preset potentiometers used for adjustments) are shown in Figure 7-1 on the next page.

NOTE 2: Tests "0" through "6" and "-" give results which are fixed for all 8531 instruments. The other tests are dependent upon individual D/A characteristics, and do not yield numerical values. These tests are included as servicing aids.

NOTE 3: The expected filter waveform of test "0" and the adjustment procedures required should any of tests "0" through "6" fail, are described in Section 7.4.4 on page 7-7..

NOTE 4: "wrt" means "with respect to".




Test points

| | | | |
|---|---|---|---|
| TP1 | Analog ground | TP8 | -6.2V reference |
| TP2 | Master oscillator | TP9 | 14-bit D-A set-up |
| TP3 | Spike blanking pulse | TP10 | 14-bit D-A output |
| TP4 | Sample pulse | TP11 | Time to sample pulse |
| TP5 | Timing control earth | TP12 | Zero D-A output |
| TP6 | Detector output | TP13 | Filter input |
| TP7 | Chassis earth | | |

Preset potentiometers

| | | | |
|---|---|---|---|
| R16 | Master oscillator frequency | R76 | 14-bit D-A offset B |
| R55 | Spike blanking width | R81 | Recorder D-A gain |
| R56 | Time to sample pulse | R82 | Recorder D-A offset |
| R57 | Sample pulse width | R88 | -19 V set |
| R70 | 14-bit D-A gain | R97 | +5 V set |
| R72 | 14-bit D-A offset A | R115 | Filter balance |

*Figure 7-1. Locations of Test Points and Adjustment Potentiometers on the Analog PC Board*





### 7.3.2 Test Equipment Required

(All test equipment must be within the calibration limits as specified in the instruction manual or calibration procedures pertaining to the particular piece of equipment.)

| Description | Representative Model | Key Characteristics |
|---|---|---|
| Digital Voltmeter (DVM) | HP 3465A | DC Volts: 0.1 to 10V<br>Accuracy: 0.001% |
| Counter Timer | TEK DC509 | Time: 1 μs to 1ms<br>Frequency: 50MHz |
| RF Power Sensor | WMI 853XX Sensor | W/Calibration Curve |
| 50MHz, 1mW Power Reference | WMI 2500 or 2520 | Calibrated |
| 50MHz Rejection Filter | WMI P/N 19989 | >35dB @ 50MHz<br>Absorptive @ 50MHz |
| Spectrum Analyzer | HP 8559A | Coverage: >300MHz |
| Oscilloscope | Tektronix 5110<br>w/5B4 & 5A22 Plug-Ins | Bandwidth: 2MHz<br>Volts/DIV: 10 μV to 5V |
| Oscilloscope Probe | Tektronix P6055 | Differential Type |
| Oscilloscope | Tektronix 2445 | Bandwidth: 70MHz<br>Volts/DIV: 1V to 5V |
| Oscilloscope Probe | Tektronix P6131 | For above scope |
| Filter Test Jig | WMI P/N 19990 | Special |

### 7.3.3 Voltage Checks and Adjustments

7.3.3.1 210V to 230V Range Setting

If the meter is to be used with an ac mains supply voltage of 210V to 230V, ensure that the mains supply input voltage selector on the rear panel is set to this range, and that the correct fuses are installed in FS1 and FS2 (250mA Slo-Blo). Perform the test given in Section 7.3.2.2, Steps 1 through 5.

7.3.3.2 105V to 120V RANGE SETTING

If the meter is to be used with an ac mains supply of 105V to 120V, ensure that the mains supply input voltage selector on the rear panel is set to this range and that the correct fuses are installed in FS1 and FS2 (500mA Slo-Blo). Connect the 8531 to the ac mains supply and perform the following steps:

1. Switch on the supply.

2. Connect the DVM LO to TP7 and DVM HI to D32 Anode. Adjust R88 to -19.0V ±0.1V

3. Move the DVM HI lead to the D35 cathode, and check that the voltage is +20.5V ±0.5V.

4. Transfer the DVM HI lead to PL6, pin 6. Adjust R97 for +5.00V ±0.05V. Remove the DVM.

5. Using the differential scope probe without connecting the oscilloscope ground to the 8531, check the ripple voltages on the plus and minus 15V and +5V supplies with respect to the chassis. (+15V at D35 anode, -15V at D32 cathode, and +5V at PL6 pin 6.) The ripple should be less than 100mV peak to peak on the +5V supply, and less than 20mV peak to peak on the other two supplies

### 7.3.4 Timing Adjustments

1. Set the counter timer to read the time between positive-going edges. Connect the timer input LO to TP5 (ground) and HI to TP2 (signal). Adjust R16 for a reading of 540.0μs ±0.5μs.

2. Set the counter timer to measure between a positive- going transition and a negative-going transition. Connect signal lead to TP3. Adjust R55 for 180μs ±5μs.

3. Connect the counter timer signal lead to TP11. Adjust R56 for 400μs ±10μs

4. Connect the counter timer to TP4. Adjust R57 for a reading of 6.0μs ±0.5μs

### 7.3.5 Filter Balance Adjustment (TEST mode "0")

NOTE: It should not be necessary to make the adjustments given in this section unless C49, C50, or R115 has been replaced on the Analog PC board.

1. Connect the special filter test jig as shown on the box. Connect the oscilloscope, ac coupled, to TP6 and the chassis. Set the sensitivity on the scope to 1mV/DIVm and the time base to 0.5ms/DIV. Remove the link from PL7. Enter the "TEST" mode (see Section 7.3.1 on page 7-2).

2. Adjust R115 for a waveform similar to Figure 7-2.

3. Remove the test jig and oscilloscope. Replace the link on PL7.

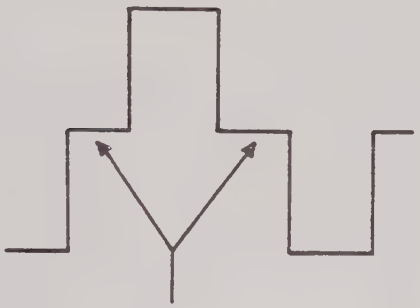


*Figure 7-2. Filter Adjustment*

NOTE: The two "pedestals" (see arrows) should not differ in voltage more than 1mV.

### 7.3.6 14 Bit D/A Adjustment (TEST mode "5")

1. Enter the "TEST" mode (see Section 7.3.1 on page 7-2).

2. Connect the DVM LO to TP7 and DVM HI to TP9. Place a jumper between TP7 and TP8.

3. Select test "5", and adjust R72 for a DVM reading of 0.000mV ±3μV.

4. Connect the DVM HI lead to TP10, and adjust R76 for 0.000mV ±5μV.

5. Remove the jumper from TP8 and TP7, and adjust R70 for 0.000mV ±10μV.

6. Remove the DVM.

### 7.3.7 Recorder D/A Adjustment (TEST mode "1")

1. Enter the "TEST" mode and select test "1".

2. Connect the DVM to the recorder output on the rear panel.

3. Adjust R82 for 0.000mV ±10μV.

4. Select test "2", and adjust R81 for 5.000mV ±100μV

### 7.3.8 Power Reference Adjustment

Before setting the power reference output level, the 8531 should be allowed to warm up for at least 15 minutes. The power reference used as a standard should be traceable to NBS. Tests must be carried out in the exact order given. The components referred to in the test are located on the Power Reference Assembly, and are accessible through cutouts in the housing of the instrument (see Figure 7-3).

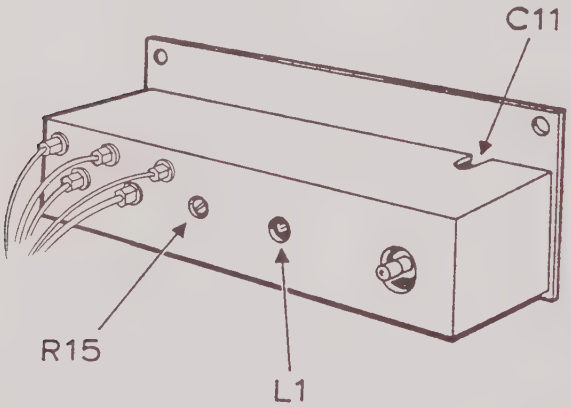



*Figure 7-3. Power Reference Calibration Components*

7.3.8.1 FREQUENCY

1. Set the counter timer to read frequency, and connect it to the POWER REFERENCE output.

2. If necessary, adjust L1 for a reading of 50MHz ±50kHz

7.3.8.2 OUTPUT LEVEL (Initial Setting)

1 Set the 8531 to read "Watts".

2. Zero the 853XX sensor and attach it to the 1mW Reference Standard. Press CAL.

3. When the calibration is complete transfer the sensor to the POWER REFERENCE output and, if necessary, adjust R15 for 1.000mW.

7.3.8.3 HARMONICS

NOTE: Harmonic adjustment should not be attempted unless components on the Power Reference Assembly PC board have been changed.

1. Connect the power reference output to the spectrum analyzer via the high-pass filter. Set the analyzer to a 175MHz center frequency, 20MHz per division, and 0dBm reference level.

2. If necessary, reduce any harmonics displayed on the analyzer to a minimum using C11. No harmonic should be higher than -55dBm in level. The high-pass filter is used so that the level of the 50MHz signal applied to the mixer in the spectrum analyzer is controlled to not cause the mixer to produce harmonics.

7.3.8.4 OUTPUT LEVEL (Final Adjustment)

Repeat Section 7.3.8.2, above. Ensure that the 853-XX sensor is correctly zeroed before applying any power to it.

## 7.4 TROUBLESHOOTING

Information provided in this section should enable a technician to locate a malfunction and determine specifically which segment of the instrument's circuitry is causing the problem. The instructions given in this section are used to trace a problem to a specific PC board. Then, the electrical description of the board contained in Section 5 (located by referring to the Table of Contents at the front of the manual), and the pertinent schematic diagram (SD) of Section 8 (located by referring to the Index for the SDs on page 8-1) can be employed to assist the technician in

circuit tracing the bad board. Ensure that devices or components external to the 8531 are not the cause of the problem before starting the troubleshooting procedure.

In general, troubleshooting of the instrument is divided into three parts. First, the procedures given in Section 7.2.1, TEST mode, on page 7-2 are performed to try to isolate the specific faulty section of the circuitry. Second a known and specific signal is applied and varied as required to allow a general determination of the severity and parameters of the problem. Third, the waveforms and dc voltage indications of suspect PC boards are traced and checked. Following this initial philosophy, the subsequent steps given in this section can be used to isolate and locate the specific section of the circuitry responsible for a particular problem.

When disconnecting the connector from the Power Reference Assembly, ensure that the metal cover of the connector cannot accidently come in contact with the PC boards to cause short circuits which might create additional faults.

### 7.4.1 Equipment Required

The same equipment used for performing the calibration procedures (Section 7.3.2 on page 7-4) can be used for these troubleshooting tests.

### 7.4.2 Check for Defective Sensor

NOTE: For any AUTO ZERO and AUTO CAL faults, the sensor should be tested first as a defective sensor is most likely the problem.

If another sensor (known to be good) is not available for performing a substitution check, the following steps can be carried out to determine whether or not the sensor is defective.

1. Enter the TEST mode (see Section 7.3.1 on page 7-2).

2. Connect a voltmeter to the LEVELLING output on the rear panel.

3. With no sensor connected to the power reference output, press the decimal point (" . ") key and then the "7" key.

4. The voltage from the levelling output should be between -250mV and -550mV for a 8531X series sensor (for an 85320 sensor, note the voltage).

5. Press the "9" key and check that the voltage is between +250mV and +550mV for a 8531X series sensor (note the voltage for an 85320 sensor).

6. If the 85320 sensor is being used, add the two voltages read in Steps 4 and 5 (ignoring the minus sign of the second reading). The result should be less than 1400mV.

7. Press the "8" key. The voltage should be less than ±50mV for an 8531X series sensor, or less than ±200mV for an 85320 sensor.

8. Connect the sensor to the POWER REFERENCE output. (Directly for the 8531X sensor, or through a 40dB attenuator for the 85320 sensor.) Check that the voltage is greater than 1.2V (for either type sensor).

If any of the above voltages are not attained, the sensor is most likely the faulty component.

### 7.4.3 Power Supply Faults

Symptoms generated by problems in the power supply are often confusing. Therefore, it is recommended that Section 7.3.3, Voltage Checks and Adjustments, on page 7-4 be performed before commencing any other tests.

If the LED in the +5V power supply regulator is lit, this indicates that the over-current circuit has shut off the supply. This can be caused by excessive current being drawn by the Processor PC board, or the over-voltage SCR firing. To decide where the problem might be, disconnect the Processor PC board and turn the unit back on. (The supply to the +5V regulator must completely disappear before the over-current circuit can reset so allow at least 15 seconds before turning the unit back on.)

### 7.4.4 Signal Channel Faults

Before performing any checks on the signal channels, it is best that a sensor known to be in good operating condition is tried with the unit because a failure to

AUTOZERO or AUTOCAL are most likely to be due to a bad sensor. Figure 7-4 shows typical waveforms that should be evident at various points in the circuitry if the instrument were in good operating condition. Radical variations in, or lack of, these waveforms can assist the user in pinpointing the location of a fault in the signal channels.

Some possible problems that might occur in the signal channel circuitry are as follows:

1. Sensor will not zero.

Possible Faults:

Sensor cable is defective.

ZERO D/A function is bad.

One chopper drive has been lost.

Check:

Cable by substitution.

Voltage from the ZERO D/A goes positive and negative (use TEST mode on page 7-2).

Outputs from the chopper drivers.

2. Failure to AUTO CAL

Possible Faults:

Incorrect sample timing.

GAIN D/A has failed.

14 bit D/A has failed.

Check:

All timing adjustments as described in Section 7.3.4 on page 7-5.

The GAIN D/A changes the output of the fourth amplifier (IC11b, pin 7) by a factor of three when using the TEST modes "." (decimal point) and "ENT".

Perform the 14 bit D/A test as given in Section 7.3.6 on page 7-5.

3. No signal channel gain.

Possible Fault:

Bad amplifier stage.

Check:

Outputs at each amplifier stage are approximately equal to those shown in Figure 7-4.

4. Noisy readings on range 1.

Possible Faults:

Filter not adjusted correctly.

Inadequate AVERAGE number with the 85320 sensor.

Check:

Filter alignment as given in Section 7.3.5 on page 7-5.

Increase AVERAGE number.

### 7.4.5 Processor Board Faults

Two possible Processor PC board faults can be indicated when the unit is first turned on. If "Er 1" is displayed at power-on, this means that a checksum test on the non-volatile RAM memory contents has failed. This could be due to a dead battery (B1). The battery voltage should be above 2.0V to guarantee memory retention.

A flashing display at power-on or RESET indicates total failure of the RAM. The signals driving the RAM, IC9, should be checked before replacing it.

Other processor board faults can manifest themselve in many different ways. If it is suspected that the board might be defective and another board (known to be good) is available, the good board should be substituted before troubleshooting the possibly defective board.

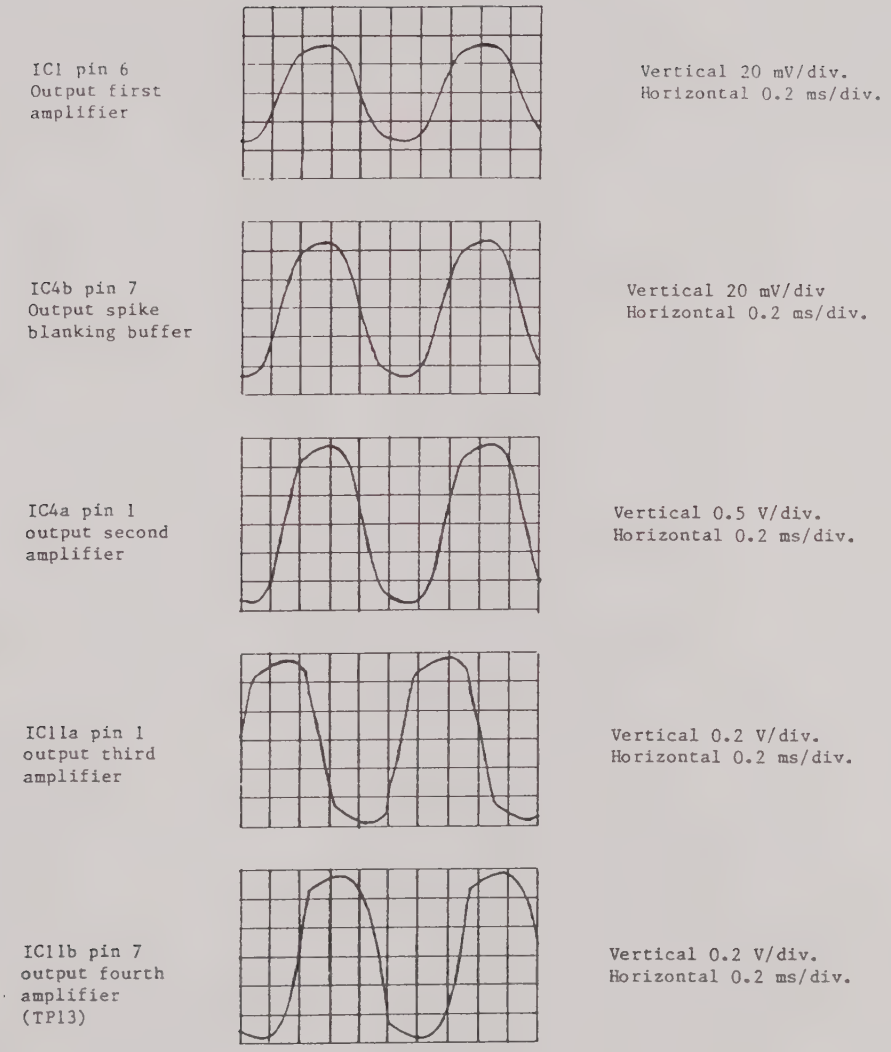



*Figure 7-4. Signal Channel Waveforms*

NOTE: All waveforms taken with an 85310 sensor connected to 0dBm and the 8531 set to range 3.

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## CALIBRATION DATA RECORDING SHEET

NOTE 1: Copies should be made of this sheet before it is used, and kept with the manual. These copies can be utilized when future calibration routines are performed on this instrument.

NOTE 2: While continuing step by step through the calibration procedures, if it should be found that any specifications cannot be met by performing the indicated adjustments, immediately go to Section 7.4, Troubleshooting, on page 7-6, and follow the instructions given therein.

Date: _____

Operator: _____

Test Number: _____ (if required)

Model 8531 Serial Number: _____

| Section of Manual | Specification | Reading |
|---|---|---|
| 7.3.3.2 Step 2 | -18.9V to -19.1V | |
| 7.3.3.2 Step 3 | +20.0V to +21.0V | |
| 7.3.3.2 Step 4 | +4.95V to +5.05V | |
| 7.3.3.2 Step 5 | +5V Supply = <100mV ripple p-p | |
| | +15V Supply = <20mV ripple p-p | |
| | -15V Supply = <20mV ripple p-p | |
| 7.3.4 Step 1 | 539.5μs to 540.5 μs | |
| 7.3.4. Step 2 | 175μs to 185 μs | |
| 7.3.4 Step 3 | 390μs to 410μs | |
| 7.3.4 Step 4 | 5.5μs to 6.5μs | |
| 7.3.6. Step 3 | -0.003mV to +0.003mV | |
| 7.3.6 Step 4 | -0.005mV to +0.005mV | |
| 7.3.6 Step 5 | -0.010mV to +0.010mV | |
| 7.3.7. Step 3 | -0.010mV to +0.010mV | |
| 7.3.7 Step 4 | +4.900mV to +5.100mV | |
| 7.3.8.1 Step 2 | 49.050MHz to 50.050MHz | |

## SECTION 8

# SCHEMATIC DIAGRAMS (SD) AND COMPONENT LAYOUT DRAWINGS


| Reference Designation | | Description | Page Number |
|---|---|---|---|
| AA01 | (Figure 8-1) | Analog PC Board Component Layout | 8-2 |
| AA01 Sheet 1 | | Analog PC Board SD | 8-3 |
| AA01 Sheet 2 | | Analog PC Board SD | 8-5 |
| AA01 Sheet 3 | | Analog PC Board SD | 8-7 |
| AA02 Sheet 4 | | Analog PC Board SD | 8-9 |
| AA02/1 | (Figure 8-2) | Processor PC Board Component Layout | 8-10 |
| AA02/1 Sheet 1 | | Processor PC Board SD | 8-11 |
| AA02/1 Sheet 2 | | Processor PC Board SD | 8-13 |
| AB01 | (Figure 8-3) | Keyboard & Display Ass'y. Component Layout | 8-15 |
| AB01 | | Keyboard & Display Ass'y. SD | 8-15 |
| AC04 | (Figure 8-4) | Power Reference Ass'y. Component Layout | 8-17 |
| AC04 | | Power Reference Ass'y. SD | 8-17 |
| GPIB Interface | (Figure 8-5) | Component Layout | 8-19 |
| GPIB Interface | | SD | 8-19 |

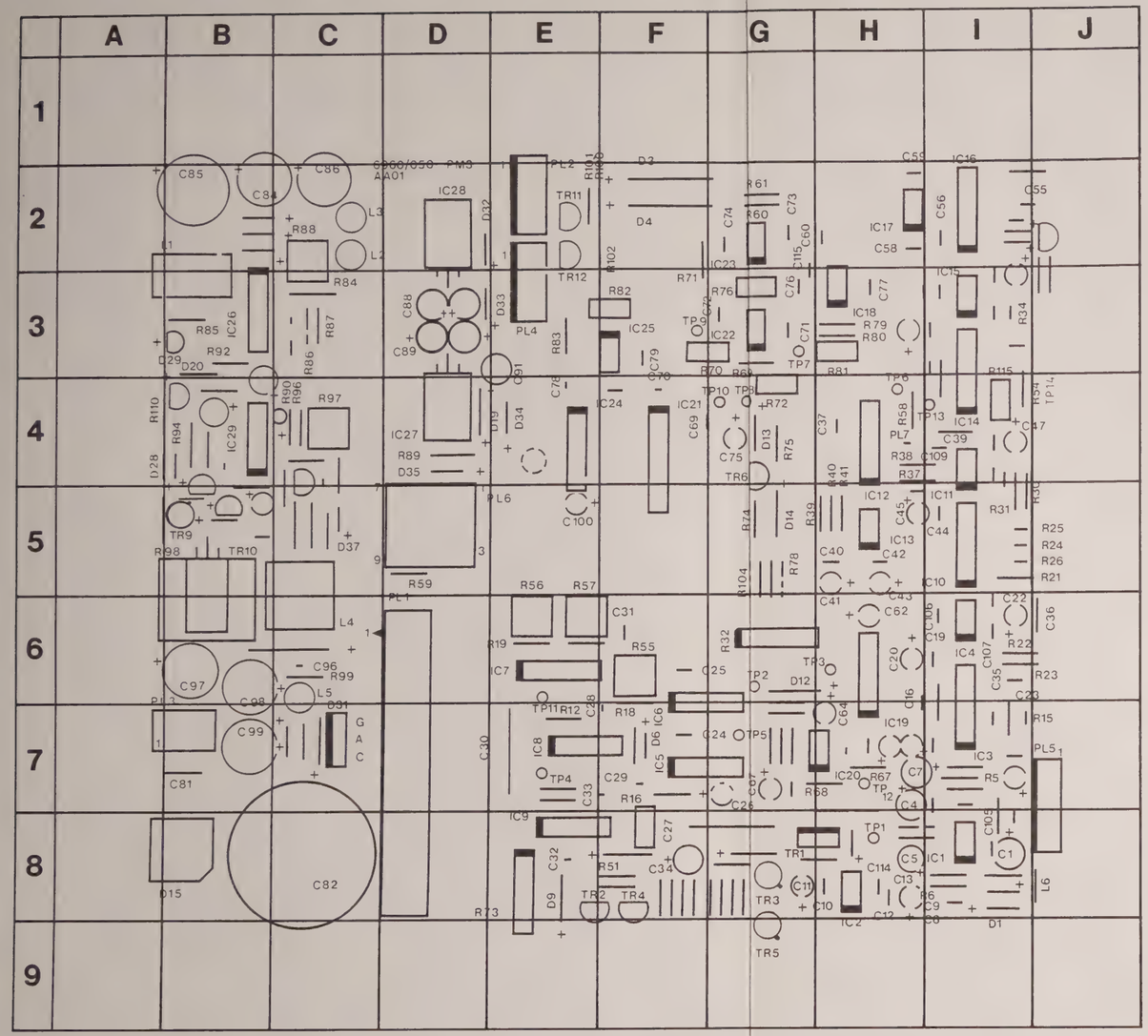
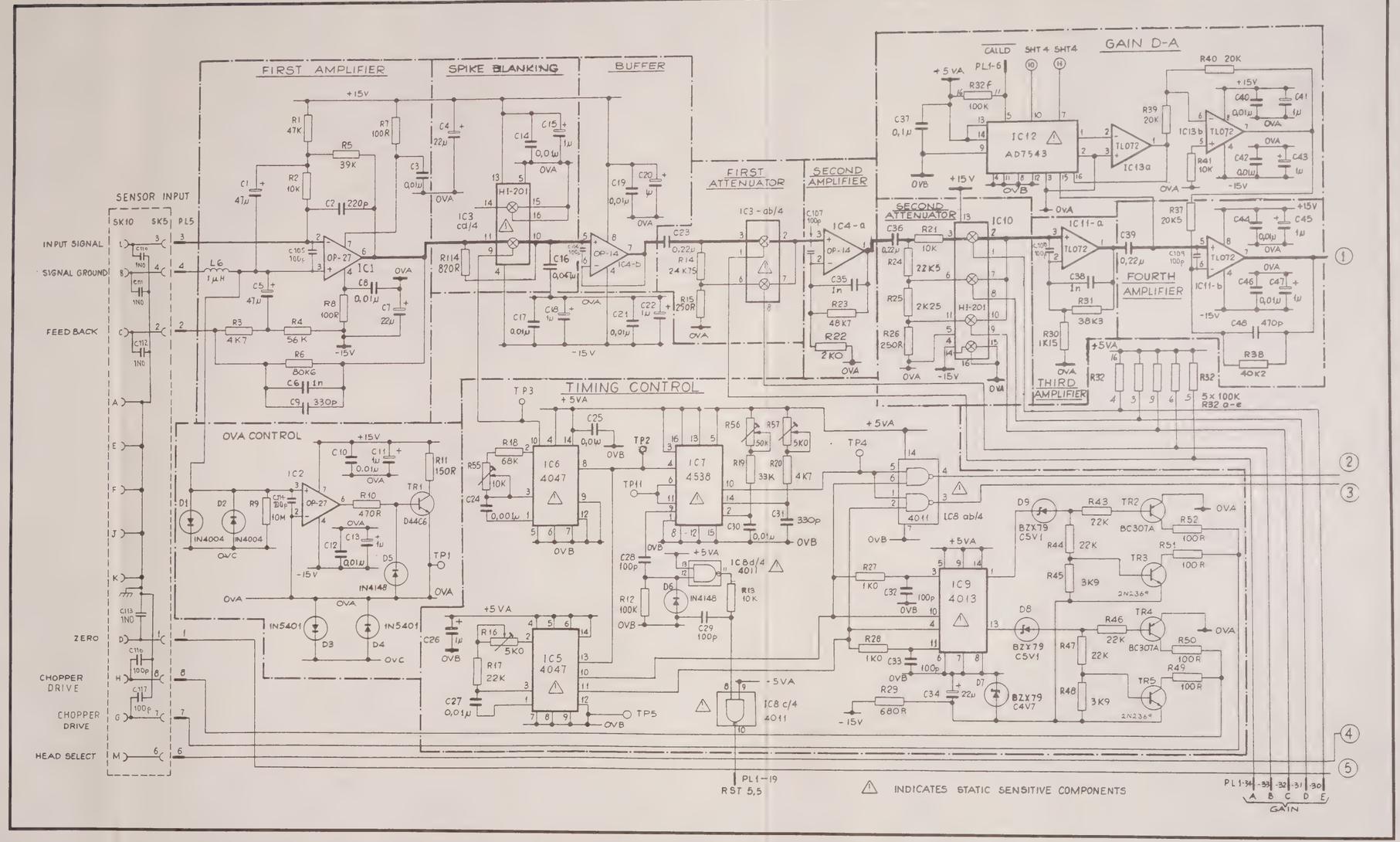
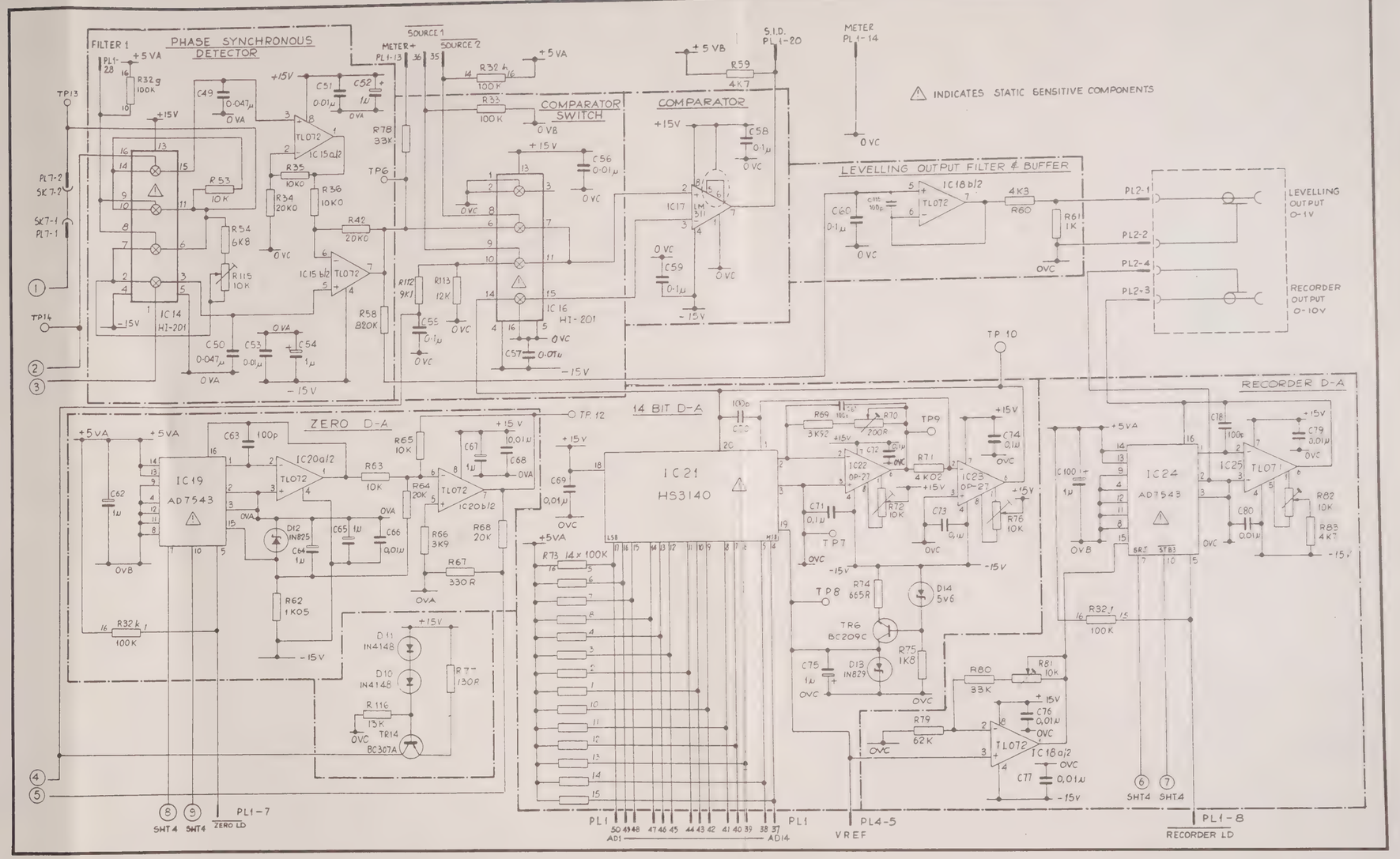



Figure 8-1 Analog PC Board

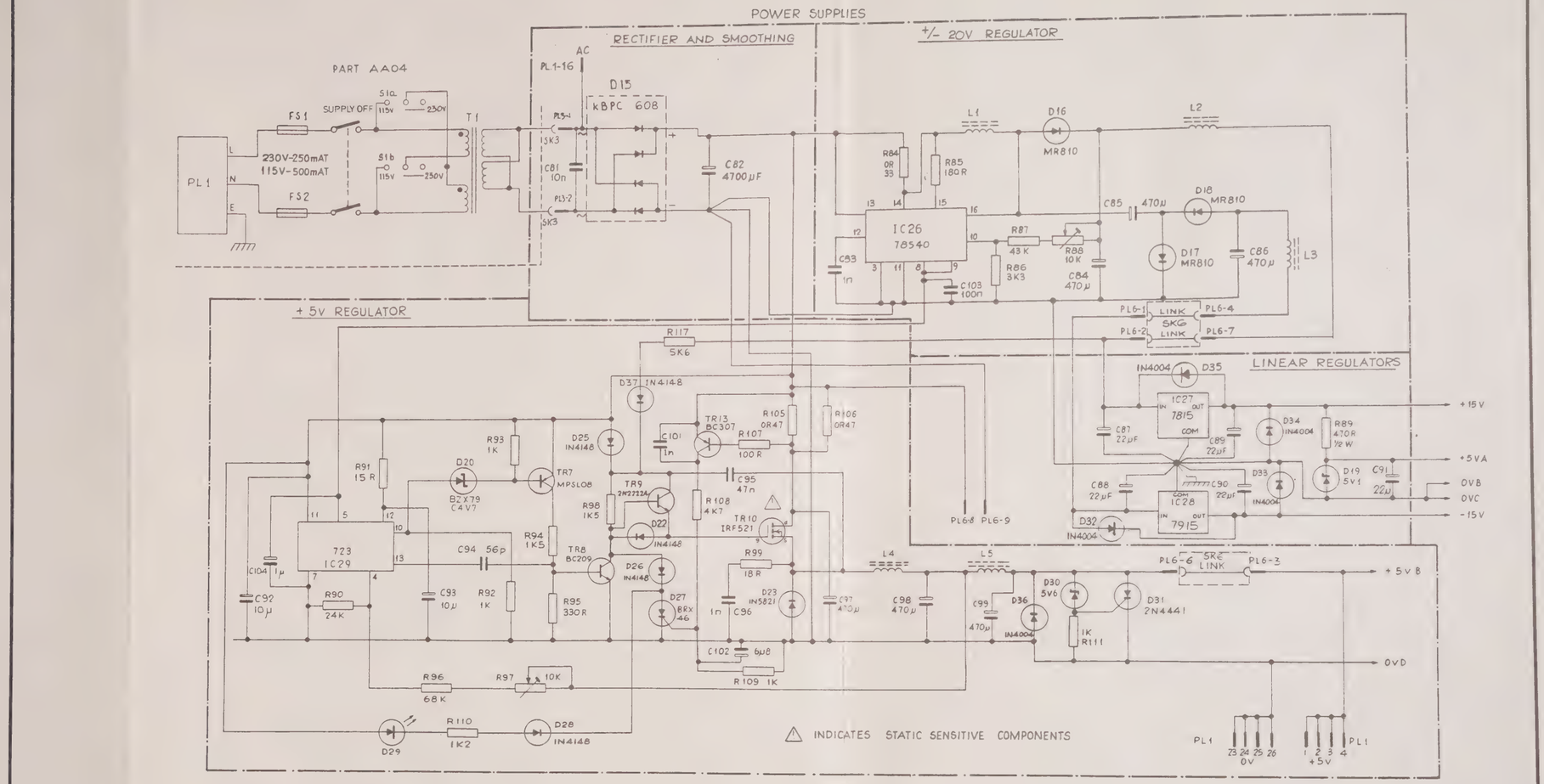
| CKT REF | GRID LOC | CKT REF | GRID LOC | CKT REF | GRID LOC | CKT REF | GRID LOC | CKT REF | GRID LOC | CKT REF | GRID LOC | CKT REF | GRID LOC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | I-8 | C55 | I-2 | C109 | I-4 | IC1 | I-8 | R1 | | R55 | F-6 | R109 | |
| C2 | | C56 | I-2 | C110 | | IC2 | H-8 | R2 | | R56 | E-6 | R110 | B-4 |
| C3 | | C57 | | C111 | | IC3 | I-7 | R3 | | R57 | E-6 | R111 | |
| C4 | H-7 | C58 | H-2 | C112 | | IC4 | I-6 | R4 | | R58 | H-4 | R112 | |
| C5 | H-8 | C59 | H-2 | C113 | | IC5 | F-7 | R5 | I-7 | R59 | D-5 | R113 | |
| C6 | I-8 | C60 | G-2 | C114 | H-8 | IC6 | F-7 | R6 | | R60 | G-2 | R114 | |
| C7 | H-7 | C61 | | C115 | G-2 | IC7 | E-6 | R7 | | R61 | G-2 | R115 | I-4 |
| C8 | | C62 | H-6 | | | IC8 | E-7 | R8 | | R62 | | | |
| C9 | I-8 | C63 | | | | IC9 | E-8 | R9 | | R63 | | | |
| C10 | H-8 | C64 | H-7 | | | IC10 | I-5 | R10 | | R64 | | | |
| C11 | G-8 | C65 | | | | IC11 | I-4 | R11 | | R65 | | | |
| C12 | H-8 | C66 | | | | IC12 | H-4 | R12 | E-7 | R66 | | | |
| C13 | H-8 | C67 | G-7 | D1 | I-8 | IC13 | H-5 | R13 | | R67 | H-7 | TP1 | H-8 |
| C14 | | C68 | | D2 | | IC14 | I-4 | R14 | | R68 | G-7 | TP2 | G-6 |
| C15 | | C69 | F-4 | D3 | F-2 | IC15 | I-3 | R15 | | R69 | G-3 | TP3 | H-6 |
| C16 | H-6 | C70 | F-4 | D4 | F-2 | IC16 | I-2 | R16 | | R70 | F-3 | TP4 | E-7 |
| C17 | | C71 | G-3 | D5 | C-6 | IC17 | H-2 | R17 | | R71 | F-2 | TP5 | G-7 |
| C18 | | C72 | G-3 | D6 | F-7 | IC18 | H-3 | R18 | F-7 | R72 | G-4 | TP6 | H-4 |
| C19 | I-6 | C73 | G-2 | D7 | | IC19 | H-6 | R19 | E-6 | R73 | | TP7 | G-3 |
| C20 | H-6 | C74 | G-2 | D8 | | IC20 | G-7 | R20 | | R74 | G-5 | TP8 | G-4 |
| C21 | | C75 | G-4 | D9 | E-8 | IC21 | F-4 | R21 | I-5 | R75 | G-4 | TP9 | F-3 |
| C22 | I-6 | C76 | G-3 | D10 | | IC22 | G-3 | R22 | I-6 | R76 | G-3 | TP10 | G-4 |
| C23 | | C77 | H-3 | D11 | | IC23 | G-2 | R23 | I-6 | R77 | | TP11 | E-6 |
| C24 | F-7 | C78 | E-4 | D12 | G-6 | IC24 | E-4 | R24 | I-5 | R78 | G-5 | TP12 | |
| C25 | F-6 | C79 | F-3 | D13 | G-4 | IC25 | F-3 | R25 | I-5 | R79 | H-3 | TP13 | H-4 |
| C26 | G-7 | C80 | | D14 | G-5 | IC26 | B-3 | R26 | I-5 | R80 | H-3 | | |
| C27 | | C81 | B-7 | D15 | B-8 | IC27 | D-4 | R27 | | R81 | H-3 | | |
| C28 | E-7 | C82 | C-8 | D16 | | IC28 | D-2 | R28 | | R82 | F-3 | | |
| C29 | E-7 | C83 | | D17 | | IC29 | B-4 | R29 | | R83 | E-3 | | |
| C30 | E-7 | C84 | B-2 | D18 | | | | R30 | I-5 | R84 | C-3 | | |
| C31 | F-6 | C85 | B-2 | D19 | D-4 | | | R31 | I-5 | R85 | B-2 | TR1 | G-8 |
| C32 | E-8 | C86 | C-2 | D20 | B-3 | | | R32 | | R86 | C-3 | TR2 | E-8 |
| C33 | E-7 | C87 | | D21 | | | | R33 | | R87 | C-3 | TR3 | G-8 |
| C34 | F-8 | C88 | D-3 | D22 | | L1 | B-2 | R34 | I-3 | R88 | C-2 | TR4 | F-8 |
| C35 | I-6 | C89 | D-3 | D23 | | L2 | C-2 | R35 | | R89 | D-4 | TR5 | G-9 |
| C36 | J-6 | C90 | | D24 | | L3 | C-2 | R36 | | R90 | C-4 | TR6 | G-4 |
| C37 | H-4 | C91 | E-3 | D25 | | L4 | C-6 | R37 | H-4 | R91 | | TR7 | |
| C38 | | C92 | | D26 | | L5 | | R38 | H-4 | R92 | B-2 | TR8 | |
| C39 | I-4 | C93 | | D27 | | L6 | I-8 | R39 | G-5 | R93 | | TR9 | B-5 |
| C40 | H-5 | C94 | | D28 | B-4 | | | R40 | H-5 | R94 | B-4 | TR10 | B-5 |
| C41 | H-5 | C95 | | D29 | B-3 | | | R41 | H-5 | R95 | | TR11 | E-2 |
| C42 | H-5 | C96 | C-6 | D30 | | | | R42 | | R96 | C-4 | TR12 | E-2 |
| C43 | H-5 | C97 | B-6 | D31 | C-7 | PL1 | D-6 | R43 | | R97 | C-4 | | |
| C44 | I-5 | C98 | B-6 | D32 | D-2 | PL2 | E-2 | R44 | | R98 | B-5 | | |
| C45 | H-5 | C99 | B-7 | D33 | D-3 | PL3 | B-7 | R45 | | R99 | C-6 | | |
| C46 | | C100 | E-5 | D34 | E-4 | PL4 | E-3 | R46 | | R100 | E-2 | | |
| C47 | I-4 | C101 | | D35 | D-4 | PL5 | J-7 | R47 | | R101 | E-2 | | |
| C48 | | C102 | | D36 | | PL6 | D-5 | R48 | | R102 | E-2 | | |
| C49 | | C103 | | D37 | C-5 | PL7 | H-4 | R49 | | R103 | | | |
| C50 | | C104 | | | | | | R50 | | R104 | G-5 | | |
| C51 | | C105 | H-8 | | | | | R51 | F-8 | R105 | | | |
| C52 | | C106 | I-6 | | | | | R52 | | R106 | | | |
| C53 | | C107 | I-6 | | | | | R53 | | R107 | | | |
| C54 | | C108 | | | | | | R54 | I-4 | R108 | | | |

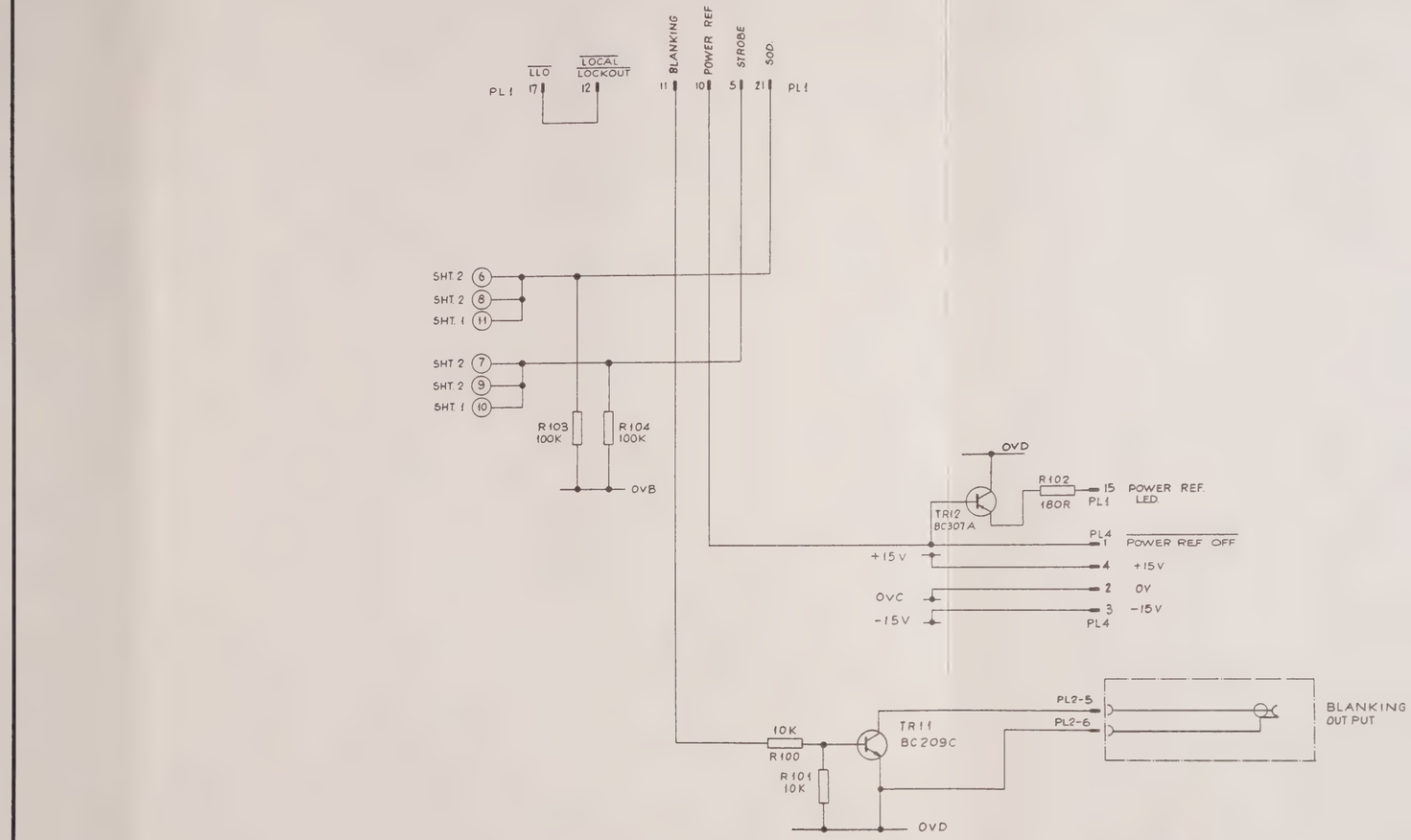



ANALOG ASSEMBLY AA01
SHEET 1 OF 4
8 - 3

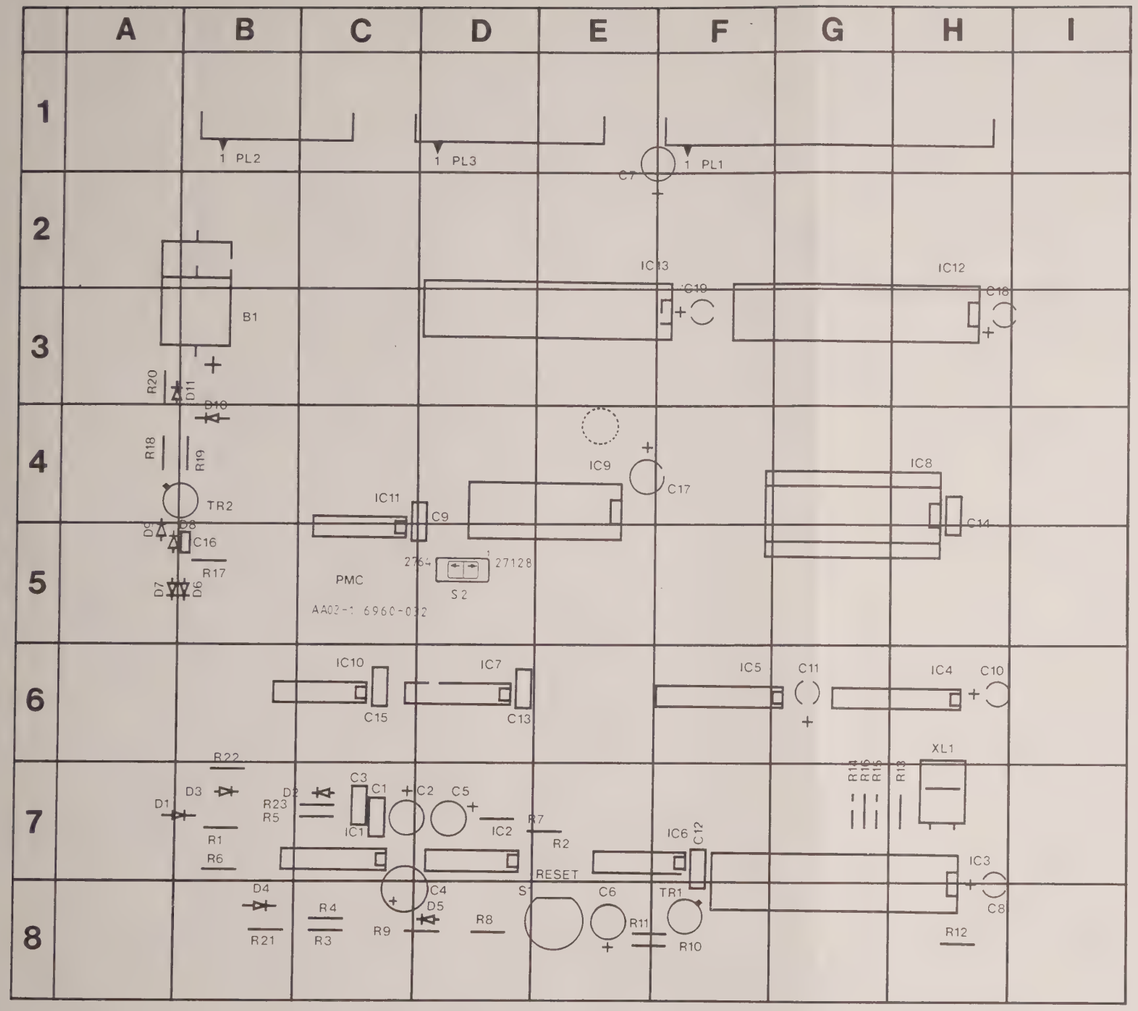



ANALOG ASSEMBLY AA01
SHEET 2 OF 4
8 - 5


POWER SUPPLIES
RECTIFIER AND SMOOTHING
+/- 20V REGULATOR
PART AA04
PL1
FS1
FS2
SUPPLY OFF
230V-250mAT
115V-500mAT
S1a
S1b
T1
AC
PL1-16
D13
kBPC 608
C81 10n
C82 4700µF
L1
L2
D16 MR810
R84 OR 33
R85 180R
IC26 78540
R87 43K
R88 10K
R86 3K3
C83 1n
C84 470µ
C85 470µ
C86 470µ
C103 100n
D18 MR810
D17 MR810
L3
PL6-1
PL6-2
PL6-4
PL6-7
LINK
SKG
+5V REGULATOR
R117 SK6
D37 IN4148
LINEAR REGULATORS
IN4004 D35
IC27 7815
IC28 7915
C87 22µF
C88 22µF
C89 22µF
C90 22µF
C91 22µ
D34 IN4004
D32 IN4004
D33 IN4004
R89 470R ½W
D19 5V1
+15V
+5VA
0VB
0VC
-15V
R91 15R
D20 BZX79 C4V7
R93 1K
D25 IN4148
TR7 MPSL08
C101 1n
TR13 BC307
R105 OR47
R106 OR47
R107 100R
C95 47n
TR9 2N2222A
R98 1K5
R108 4K7
D22 IN4148
TR10 IRF521
R94 1K5
TR8 BC209
D26 IN4148
R99 18R
D27 BRX 46
D23 IN5821
C96 1n
C97 470µ
C98 470µ
C99 470µ
D36 IN4004
D30 5V6
D31 2N4441
L4
L5
PL6-6
PL6-3
+5VB
723 IC29
C104 1µ
C92 10µ
R90 24K
C93 10µ
C94 56p
R92 1K
R95 330R
C102 6µ8
R109 1K
1K R111
0VD
R96 68K
R97 10K
D29
R110 1K2
D28 IN4148
INDICATES STATIC SENSITIVE COMPONENTS
PL1
23 24 25 26
0V
1 2 3 4
+5V

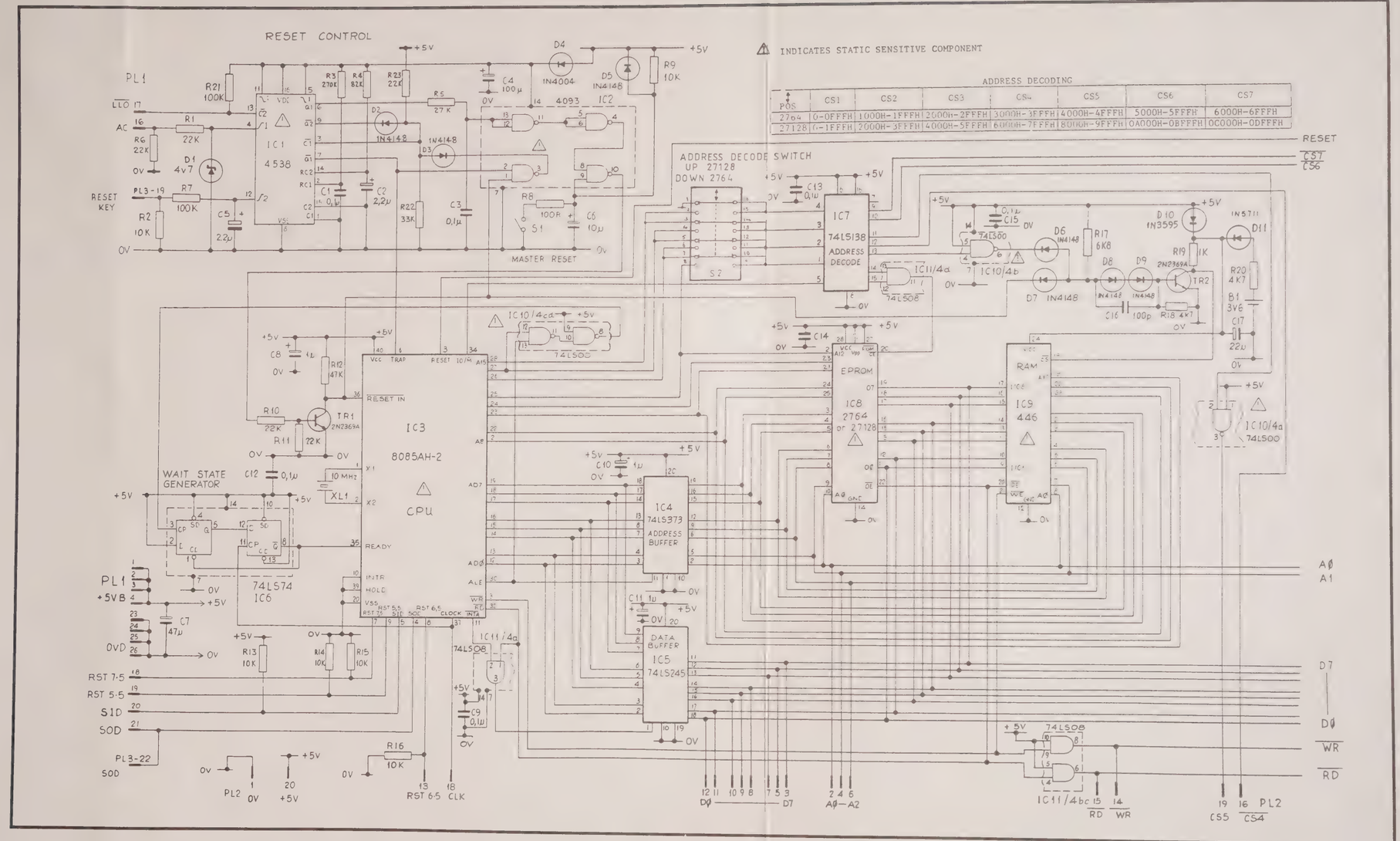


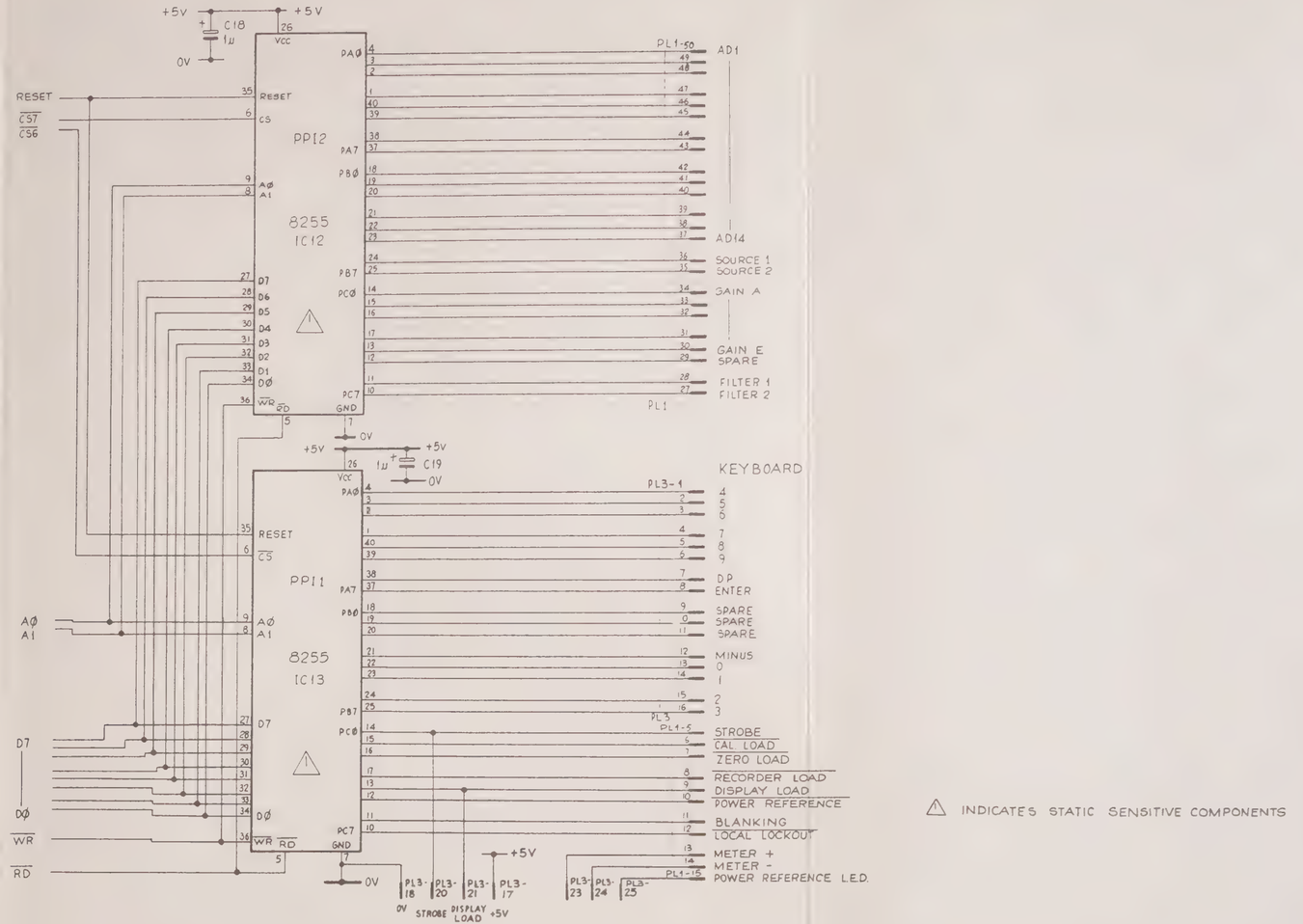

ANALOG ASSEMBLY AA01
SHEET 4 OF 4
8 - 9




| CKT REF | GRID LOC | CKT REF | GRID LOC |
|---|---|---|---|
| B1 | B-3 | IC8 | H-4 |
| | | IC9 | E-4 |
| | | IC10 | C-6 |
| | | IC11 | C-4 |
| C1 | C-7 | IC12 | H-2 |
| C2 | D-7 | IC13 | E-3 |
| C3 | C-7 | | |
| C4 | D-8 | | |
| C5 | D-7 | | |
| C6 | E-8 | PL1 | F-1 |
| C7 | F-1 | PL2 | B-1 |
| C8 | I-8 | PL3 | D-1 |
| C9 | D-4 | | |
| C10 | H-6 | | |
| C11 | G-6 | | |
| C12 | F-7 | R1 | B-7 |
| C13 | D-6 | R2 | E-7 |
| C14 | H-4 | R3 | C-8 |
| C15 | C-6 | R4 | C-8 |
| C16 | B-5 | R5 | C-7 |
| C17 | F-4 | R6 | B-7 |
| C18 | H-3 | R7 | D-7 |
| C19 | F-3 | R8 | D-8 |
| | | R9 | D-8 |
| | | R10 | F-8 |
| | | R11 | F-8 |
| D1 | B-7 | R12 | H-8 |
| D2 | C-7 | R13 | H-7 |
| D3 | B-7 | R14 | G-7 |
| D4 | B-8 | R15 | H-7 |
| D5 | D-8 | R16 | G-7 |
| D6 | B-5 | R17 | B-5 |
| D7 | B-5 | R18 | A-4 |
| D8 | B-5 | R19 | B-4 |
| D9 | A-5 | R20 | A-3 |
| D10 | B-4 | R21 | B-8 |
| D11 | B-3 | R22 | B-7 |
| | | R23 | C-7 |
| | | | |
| | | | |
| | | | |
| IC1 | C-7 | S1 | E-8 |
| IC2 | D-7 | S2 | D-5 |
| IC3 | H-7 | | |
| IC4 | H-6 | | |
| IC5 | F-6 | TR1 | F-8 |
| IC6 | F-7 | TR2 | B-4 |
| IC7 | D-6 | | |

Figure 8-2 Processor PC Board


RESET CONTROL
INDICATES STATIC SENSITIVE COMPONENT
ADDRESS DECODING
POS | CS1 | CS2 | CS3 | CS4 | CS5 | CS6 | CS7
2764 | 0-0FFFH | 1000H-1FFFH | 2000H-2FFFH | 3000H-3FFFH | 4000H-4FFFH | 5000H-5FFFH | 6000H-6FFFH
27128 | 0-1FFFH | 2000H-3FFFH | 4000H-5FFFH | 6000H-7FFFH | 8000H-9FFFH | 0A000H-0BFFFH | 0C000H-0DFFFH
ADDRESS DECODE SWITCH
UP 27128
DOWN 2764
IC1 4538
IC2 4093
IC3 8085AH-2 CPU
IC4 74LS373 ADDRESS BUFFER
IC5 74LS245 DATA BUFFER
IC6 74LS74
IC7 74LS138 ADDRESS DECODE
IC8 2764 or 27128 EPROM
IC9 446 RAM
IC10/4a 74LS00
IC10/4b 74LS00
IC10/4c 74LS00
IC10/4d 74LS00
IC11/4a 74LS08
IC11/4b 74LS08
IC11/4c 74LS08
WAIT STATE GENERATOR
MASTER RESET
RESET KEY
TR1 2N2369A
TR2 2N2369A
XL1 10 MHz
RESET
CS7
CS6
A0
A1
D7
D0
WR
RD
CS5
CS4
PL1
PL2
PL3-19
PL3-22
RST 7.5
RST 5.5
SID
SOD
CLK


+5V
C18
1µ
0V
+5V
26
VCC
PPI2
8255
IC12
RESET
35
RESET
CS7
CS6
6
CS
PA0
PA7
PB0
PB7
PC0
PC7
GND
A0
A1
9
8
D7
D6
D5
D4
D3
D2
D1
D0
27
28
29
30
31
32
33
34
WR
RD
36
5
7
PL1-50
AD1
AD14
SOURCE 1
SOURCE 2
GAIN A
GAIN E
SPARE
FILTER 1
FILTER 2
PL1
C19
PPI1
IC13
KEYBOARD
PL3-1
4
5
6
7
8
9
DP
ENTER
SPARE
SPARE
SPARE
MINUS
0
1
2
3
PL3
PL1-5
STROBE
CAL LOAD
ZERO LOAD
RECORDER LOAD
DISPLAY LOAD
POWER REFERENCE
BLANKING
LOCAL LOCKOUT
METER +
METER -
POWER REFERENCE L.E.D.
PL1-15
PL3-18
PL3-20
PL3-21
PL3-17
PL3-23
PL3-24
PL3-25
0V
STROBE
DISPLAY LOAD
+5V
INDICATES STATIC SENSITIVE COMPONENTS

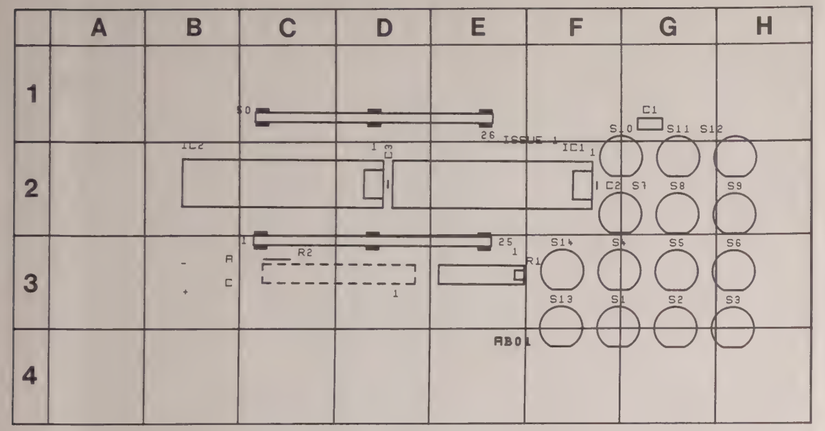
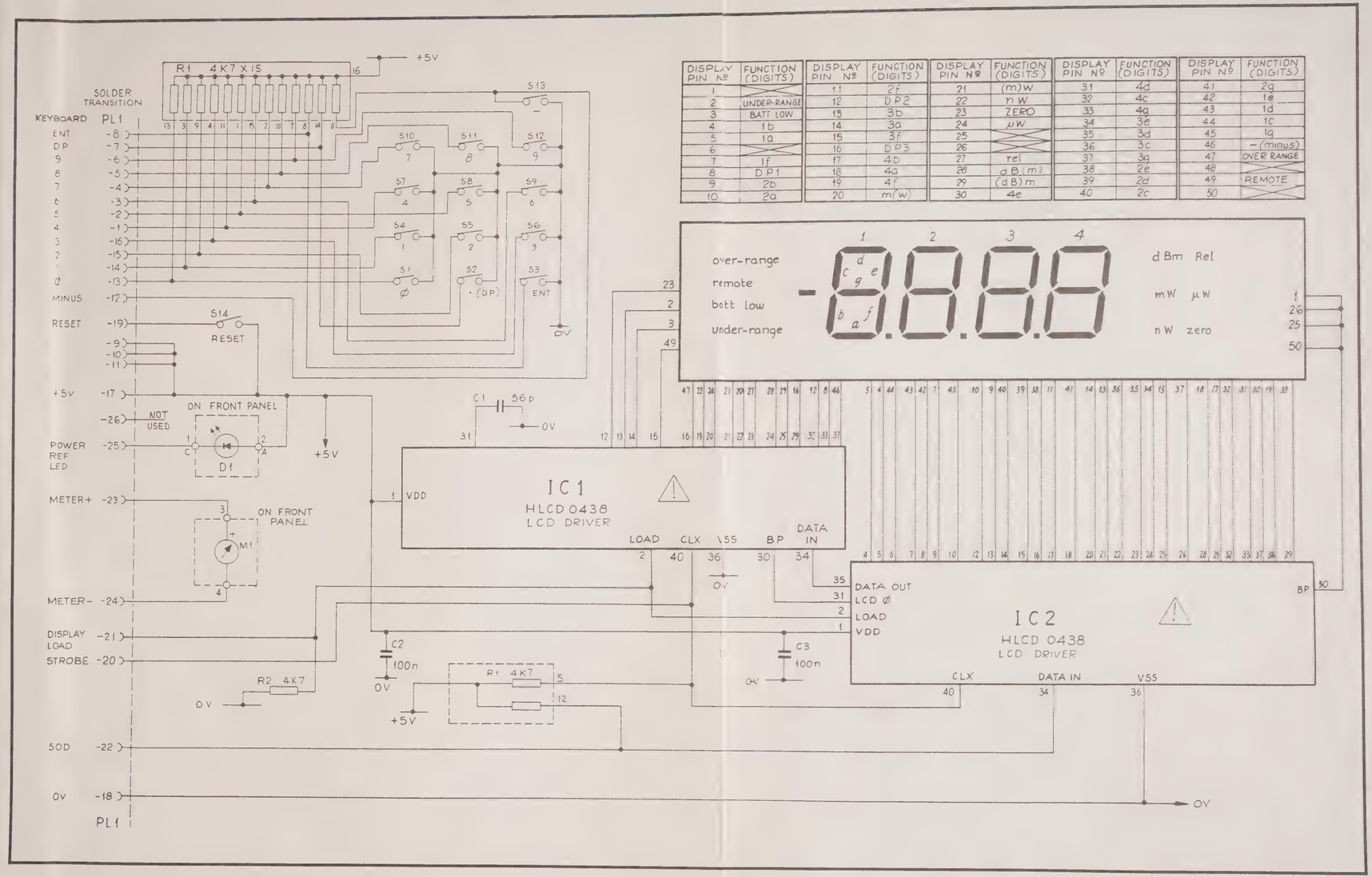



Figure 8-3 Keyboard & Display PC Board

| CKT REF | GRID LOC | CKT REF | GRID LOC |
|---|---|---|---|
| C1 | G-1 | S-6 | H-3 |
| C2 | F-2 | S-7 | G-2 |
| C3 | D-2 | S-8 | G-2 |
| | | S-9 | H-2 |
| | | S-10 | G-2 |
| IC1 | E-2 | S-11 | G-2 |
| IC2 | C-2 | S-12 | H-2 |
| | | S-13 | F-3 |
| | | S-14 | F-3 |
| R1 | E-3 | | |
| R2 | C-3 | | |
| | | | |
| | | | |
| S1 | G-3 | | |
| S2 | G-3 | | |
| S3 | H-3 | | |
| S4 | G-3 | | |
| S5 | G-3 | | |




| DISPLAY PIN Nº | FUNCTION (DIGITS) | DISPLAY PIN Nº | FUNCTION (DIGITS) | DISPLAY PIN Nº | FUNCTION (DIGITS) | DISPLAY PIN Nº | FUNCTION (DIGITS) | DISPLAY PIN Nº | FUNCTION (DIGITS) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 11 | 2f | 21 | (m)W | 31 | 4d | 41 | 2g |
| 2 | UNDER-RANGE | 12 | DP2 | 22 | nW | 32 | 4c | 42 | 1e |
| 3 | BATT LOW | 13 | 3b | 23 | ZERO | 33 | 4g | 43 | 1d |
| 4 | 1b | 14 | 3a | 24 | µW | 34 | 3e | 44 | 1c |
| 5 | 1a | 15 | 3f | 25 | | 35 | 3d | 45 | 1g |
| 6 | | 16 | DP3 | 26 | | 36 | 3c | 46 | – (minus) |
| 7 | 1f | 17 | 4b | 27 | rel | 37 | 3g | 47 | OVER RANGE |
| 8 | DP1 | 18 | 4a | 28 | dB(m) | 38 | 2e | 48 | |
| 9 | 2b | 19 | 4f | 29 | (dB)m | 39 | 2d | 49 | REMOTE |
| 10 | 2a | 20 | m(W) | 30 | 4e | 40 | 2c | 50 | |

POWER METER KEY BOARD AND DISPLAY ASSEMBLY AB01
SHEET 1 OF 1

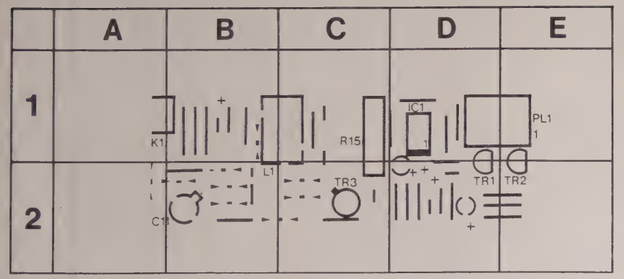
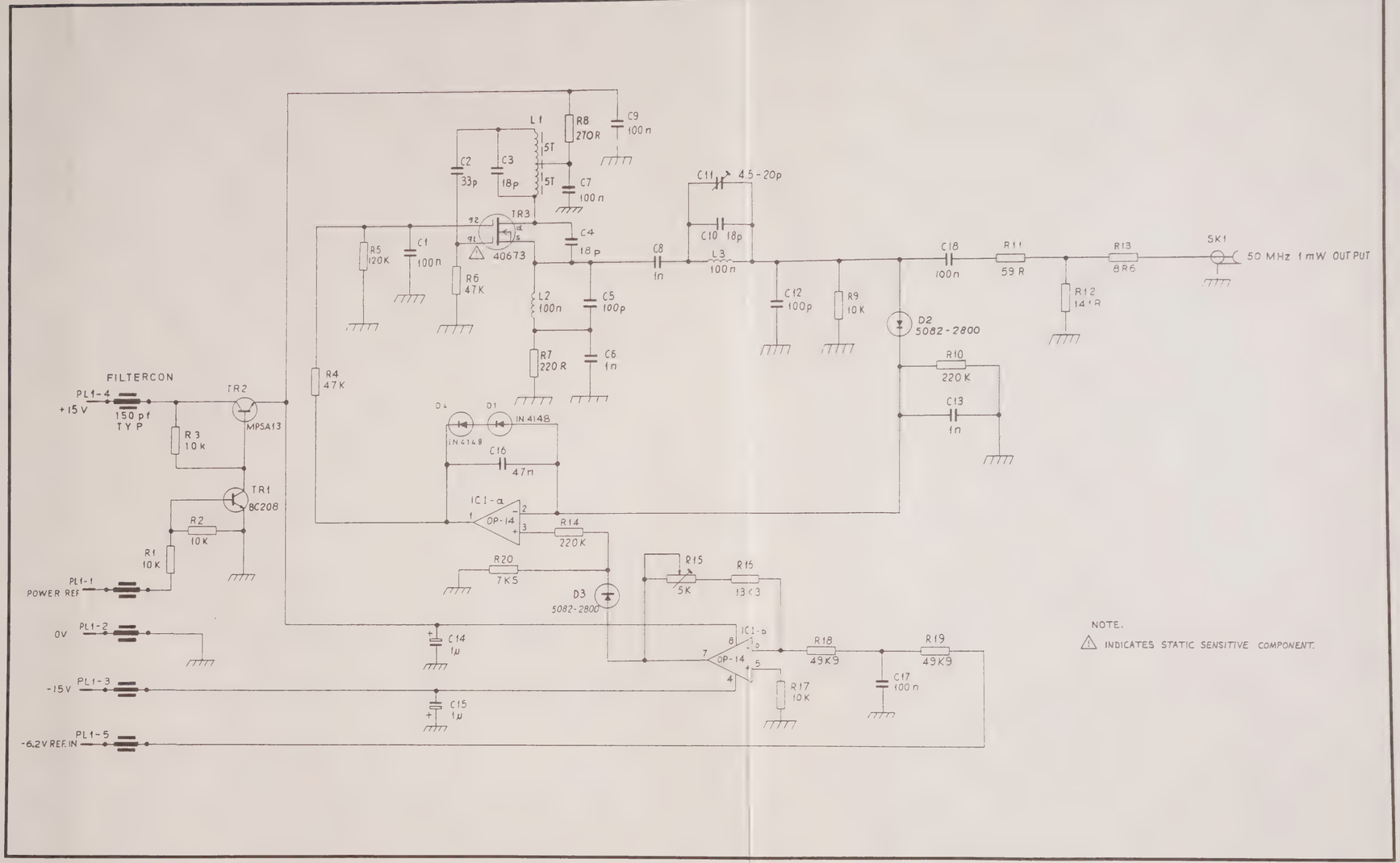



Figure 8-4 Power Reference PC Board

| CKT REF | GRID LOC | CKT REF | GRID LOC | CKT REF | GRID LOC |
|---|---|---|---|---|---|
| C1 | | R1 | | TR1 | D-2 |
| C2 | | R2 | | TR2 | E-2 |
| C3 | | R3 | | TR3 | C-2 |
| C4 | | R4 | | | |
| C5 | | R5 | | | |
| C6 | | R6 | | | |
| C7 | | R7 | | | |
| C8 | | R8 | | | |
| C9 | | R9 | | | |
| C10 | | R10 | | | |
| C11 | B-2 | R11 | | | |
| | | R12 | | | |
| | | R13 | | | |
| IC1 | D-1 | R14 | | | |
| | | R15 | C-1 | | |
| L1 | C-1 | | | | |
| | | SK1 | A-1 | | |
| PL1 | E-1 | | | | |




POWER REFERENCE ASSEMBLY AC04
SHEET 1 OF 1

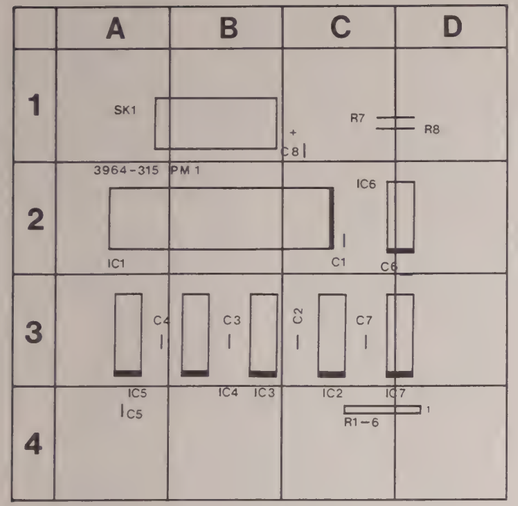
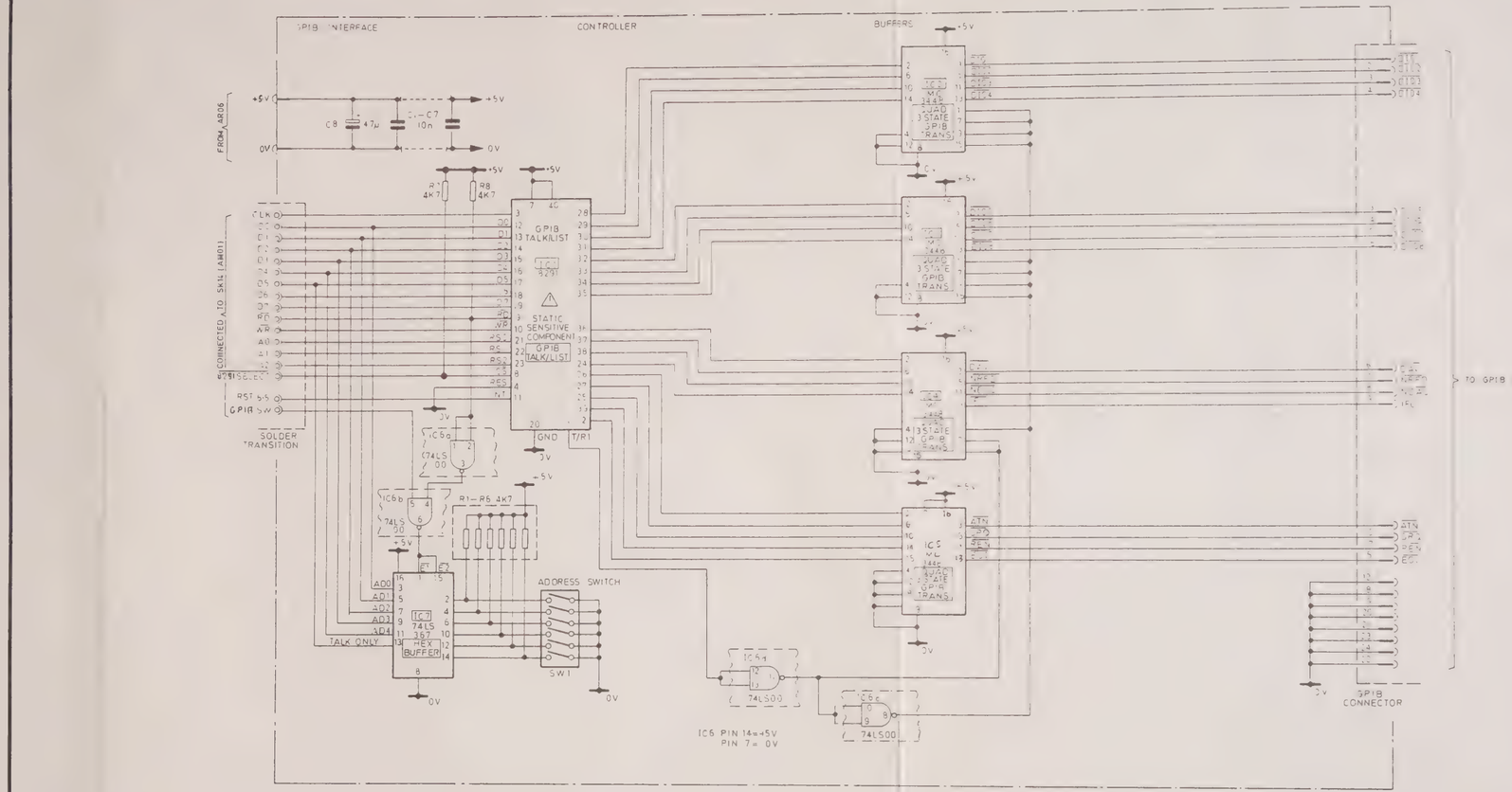



Figure 8-5 GPIB Interface PC Board

| CKT REF | GRID LOC | CKT REF | GRID LOC |
|---|---|---|---|
| C1 | C-2 | R1-6 | D-4 |
| C2 | C-3 | R2 | |
| C3 | B-3 | R3 | |
| C4 | B-3 | R4 | |
| C5 | | R5 | |
| C6 | D-3 | R6 | |
| C7 | C-3 | R7 | D-1 |
| C8 | C-1 | R8 | D-1 |
| | | | |
| | | | |
| | | SK1 | B-1 |
| IC1 | B-2 | | |
| IC2 | C-3 | | |
| IC3 | C-3 | | |
| IC4 | B-3 | | |
| IC5 | A-3 | | |
| IC6 | D-2 | | |
| IC7 | D-3 | | |




GPIB INTERFACE MODULE
SHEET 1 OF 1

# SECTION 9

# REPLACEABLE PARTS LISTINGS

Contents


| | | Page No. |
|---|---|---|
| 9.1 | INTRODUCTION | 9-1 |
| 9.2 | ABBREVIATIONS | 9-2 |
| 9.3 | CHANGES IN COMPONENT TYPE OR VALUE | 9-3 |
| 9.4 | ORDERING INFORMATION | 9-3 |
| 9.5 | COMPONENT PART DESCRIPTIONS (Location Index shown below) | 9-3 |

| Reference Designation | Description | |
|---|---|---|
| AA0 | Model 8531 Power Meter | 9-3 |
| AA01 | Analog PC Board Ass'y. | 9-3 |
| AA02/1 | Processor PC Board Ass'y. | 9-6 |
| AA03 | Front Panel Ass'y. | 9-6 |
| AA04 | Rear Panel Ass'y. | 9-6 |
| AA06 | Ribbon Cable 50-way | 9-7 |
| AA07 | Ribbon Cable 26-way | 9-7 |
| AA10 | Power Link Socket | 9-7 |
| AA11 | GPIB Interface Module | 9-7 |
| AB01 | Keyboard and Display Ass'y. | 9-7 |
| AB04 | Cable Ass'y. 6-way | 9-7 |
| AB05 | Cable Ass'y. 2-way | 9-7 |
| AB06 | GPIB PC Board Ass'y. | 9-7 |
| AB07 | Switch PC Board Ass'y. | 9-7 |
| AB08 | Cable Ass'y. | 9-7 |
| AC03 | Power Ref. Cable Ass'y. | 9-8 |
| AC04 | Power Ref. Ass'y. | 9-8 |
| AF03 | Sensor Input Ass'y. | 9-8 |
| AF04 | RF Cable Ass'y. | 9-8 |
| AF08 | Sensor Cable Ass'y. | 9-8 |
| | Mechanical Parts | 9-8 |
| Figure 9-1 | Miscellaneous Mechanical Parts Location | 9-9 |


## 9.1 INTRODUCTION

Each sub-assembly or PC board in the 8531 has been assigned a reference designator number, e.g. AA01, AB06, etc.

The complete component reference includes its reference designator as a prefix, e.g. AA01 C1 (capacitor C1 on PC board number AA01) but, for convenience in the part listings and on the schematic diagrams (SD), the prefix is omitted unless it is needed to

avoid confusion. However, when ordering replacements or when referencing specific parts in any correspondence the complete component reference must be quoted.

## 9.2 ABBREVIATIONS

The following abbreviations (listed in alphabetical order) will be used in the component part descriptions given in this section:

| | |
|---|---|
| ADC | analog-to-digital converter |
| AX | axial |
| CAP | capacitor |
| CARR | carrier |
| CARB | carbon |
| CC | carbon composition |
| CDE CNV | code converter |
| CER | ceramic |
| CERM | cermet |
| CF | carbon film |
| COAX | coaxial |
| CON | connector |
| CTR | counter |
| DAC | digital-to-analog converter |
| DEC/DMX | decoder/demultiplexer |
| DECOD | decoder |
| DIL | dual in-line |
| DIV | divider |
| DRIV | driver |
| ELEC | electrolytic |
| ENCOD | encoder |
| FEM | female |
| FF | flip-flop (bistable) |
| FILTERCON | filtering capacitor |
| GER | germanium |
| GP | general purpose |
| ICA | integrated circuit - analog |
| ICD | integrated circuit - digital |
| IND | inductor |
| INV | invertor |
| LD/T | lead through |
| MF | metal film |
| MG | metal glaze |
| MISC | miscellaneous |
| MO | metal oxide |
| MP | microprocessor |
| MP SUPP | microprocessor support |
| MUX | multiplexer |
| NET | network |
| PC | polycarbonate |
| PETP | (polyester) polyethene terephthalate |
| PS | polystyrene |
| PLL | phase-locked loop |
| Q/ACT | quick acting |
| RECT | rectifier |
| RE | resistor |
| RV | resistor, variable |
| RX | receiver |
| SAPPH | sapphire |
| SEC | secondary |
| SCHM | Schmitt |
| SH REG | shift register |
| SIL | silicon |
| SW | switch |
| T/LAG | time lag |
| TANT | tantalum |
| TOG | toggle |
| TRANS | transistor |
| TX | transistor |
| VAR | variable |
| VREG | voltage regulator |
| W | watts at 70 deg C |
| WW | wirewound |
| X | miscellaneous item |
| XL | crystal |
| ! | static sensitive component |
| % + | asymmetric tolerance |
| ≠ | programmed EPROM |

## 9.3 CHANGES IN COMPONENT TYPE OR VALUE

Whenever a component is changed during the production of the instrument, a code level update will be specified in the MANUAL CORRECTIONS section of this manual. A change in the type or value of the components described in these replaceable parts listings will occur when improvements in performance are made as part of a policy of continuous development, or due to supply difficulties.

Components in the listings designated by an asterisk " * " have their values selected by the factory during production to achieve specific performance parameters, and may vary slightly in value from instrument to instrument.

## 9.4 ORDERING INFORMATION

When ordering replacement components, address the order either to the Wavetek Microwave Sales Department (Spare Parts) or to the nearest Wavetek representative (shown on the "Thank You" card that came with this manual), and specify the following information:

1. Model number, serial number, and code level of the instrument. (Serial number and code level are shown on the decal located at the rear of the instrument housing.)

2. Complete circuit reference including PC board or sub-assembly designation (e.g. AA01 C2, AB06 D1, etc.).

3. Part number of the component.

## 9.5 COMPONENT PART DESCRIPTIONS

| *Circuit Reference* | *Description* | *Part No.* |
|---|---|---|
| | Unit AA0 - RF POWER METER | |
| | When ordering, prefix circuit reference with AA0. | |
| | Complete unit | 06960-001 |
| FS1 | FUSE T/LAG 0.25A 20X5 | 23411-055P |
| FS2 | FUSE T/LAG 0.25A 20X5 | 23411-055P |
| MP5 | SWITCH COVER - VOLTS ADJUST | 37590-211G |
| X21 | FUSE T/LAG 0.50A 20X5 | 23411-056X |
| X22 | CON ASSY FEM 3 FREE CEE22 S | 23424-158H |
| X25 | BATTERY PRI 3V LITH 0.4AH | 23722-110W |
| | Unit AA01 - ANALOGUE PCB ASSY. | |
| | Complete unit | 06960-010 |
| C1 | CAP TANT 47U 6V 20% BEAD | 26486-232A |
| C2 | CAP CER 220P 100V 5% * | 26343-580E |
| C3 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C4 | CAP TANT 22U 16V 20% BEAD | 26486-230B |
| C5 | CAP TANT 47U 16V 20% | 26486-233Z |
| C6 | CAP CER 1N0 100V 5% * | 26343-583S |
| C7 | CAP TANT 22U 16V 20% BEAD | 26486-230B |
| C8 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C9 | CAP CER 330P 100V 5% * | 26343-581G |
| C10 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C11 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C12 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C13 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C14 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C15 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C16 | CAP CER 47N 25V 20% DISC | 26383-017U |
| C17 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C18 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C19 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C20 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C21 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C22 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C23 | CAP PETP 220N 63V 10% RAD | 26582-406T |
| C24 | CAP CER 1N0 100V 5% * | 26343-583S |
| C25 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C26 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C27 | CAP PS 10N0 63V 2% RAD | 26538-770T |
| C28 | CAP CER 100P 63V 2% PLATE | 26343-477V |
| C29 | CAP CER 100P 63V 2% PLATE | 26343-477V |
| C30 | CAP PS 10N0 63V 2% RAD | 26538-770T |
| C31 | CAP CER 330P 100V 5% * | 26343-581G |
| C32 | CAP CER 100P 63V 2% PLATE | 26343-477V |
| C33 | CAP CER 100P 63V 2% PLATE | 26343-477V |
| C34 | CAP TANT 22U 16V 20% BEAD | 26486-230B |
| C35 | CAP CER 1N0 100V 5% * | 26343-583S |
| C36 | CAP PETP 220N 63V 10% RAD | 26582-406T |
| C37 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C38 | CAP CER 1N0 100V 5% * | 26343-583S |
| C39 | CAP PETP 220N 63V 10% RAD | 26582-406T |
| C40 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C41 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C42 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C43 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C44 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C45 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C46 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C47 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C48 | CAP CER 470P 100V 5% * | 26343-582V |
| C49 | CAP PETP 47N 63V 10% RAD MIN | 26582-428J |
| C50 | CAP PETP 47N 63V 10% RAD MIN | 26582-428J |
| C51 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C52 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C53 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C54 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C55 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C56 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C57 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C58 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C59 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C60 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |

| Circuit Reference | Description | Part No. |
|---|---|---|
| C61 | CAP CER 100P 63V 2% PLATE | 26343-477V |
| C62 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C63 | CAP CER 100P 63V 2% PLATE | 26343-477V |
| C64 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C65 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C66 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C67 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C68 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C69 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C70 | CAP CER 100P 63V 2% PLATE | 26343-477V |
| C71 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C72 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C73 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C74 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C75 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C76 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C77 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C78 | CAP CER 100P 63V 2% PLATE | 26343-477V |
| C79 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C80 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C81 | CAP CER 10N 50V 20% X7R MON AX | 26346-120Y |
| C82 | CAP ELEC 4700U 40V 10%+ PCB | 26422-321W |
| C83 | CAP CER 1N0 63V 10% PLATE | 26383-585M |
| C84 | CAP ELEC 470U 25V 20%+ PCB | 26421-129T |
| C85 | CAP ELEC 470U 63V 20%+ PCB | 26421-136C |
| C86 | CAP ELEC 470U 25V 20%+ PCB | 26421-129T |
| C87 | CAP TANT 22U 35V 20% | 26486-231K |
| C88 | CAP TANT 22U 35V 20% | 26486-231K |
| C89 | CAP TANT 22U 16V 20% BEAD | 26486-230B |
| C90 | CAP TANT 22U 15V 20% BEAD | 26486-230B |
| C91 | CAP TANT 22U 16V 20% BEAD | 26486-230B |
| C92 | CAP TANT 10U 35V 20% BEAD | 26486-225C |
| C93 | CAP TANT 10U 35V 20% BEAD | 26486-225C |
| C94 | CAP CER 56P 63V 2% PLATE | 26343-474J |
| C95 | CAP CER 47N 25V 20% DISC | 26383-017U |
| C96 | CAP CER 1N0 63V 10% PLATE | 26383-585M |
| C97 | CAP ELEC 470U 25V 20%+ PCB | 26421-129T |
| C98 | CAP ELEC 470U 16V 20%+ PCB | 26421-127W |
| C99 | CAP ELEC 470U 20%+ PCB | 26421-127W |
| C100 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C101 | CAP CER 1N0 63V 10% PLATE | 26383-585M |
| C102 | CAP TANT 6U8 6V 20% BEAD | 26486-221T |
| C103 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C104 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C105 to C109 | CAP CER 100P 100V 10% EMCON 25028 EM 100RD 101K | |
| C110 to C113 | CAP CHIP 1N0 100V 10% STC : 0805FX7R | |
| C114 | CAP CER 100P 100V 10% EMCON : 5028 EM 100RD 101K | |
| C115 | CAP CER 100P 100V 10% EMCON : 5028 EM 100RD 101K | |
| C116 | CAP CHIP 100P 100V 10% STC : 0805FX7R | |
| C117 | CAP CHIP 100P 100V 10% STC : 0805FX7R | |
| D1 | DI RECT 1N4004 400V | 28357-028K |
| D2 | DI RECT 1N4004 400V | 28357-028K |
| D3 | DI RECT 1N5401 100V | 28355-723N |
| D4 | DI RECT 1N5401 100V | 28355-723N |
| D5 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D6 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D7 | DI ZEN BZX79C 4.7V 5% | 28371-371F |
| D8 | DI ZEN BZX79C 5.1V 5% | 28371-401U |
| D9 | DI ZEN BZX79C 5.1V 5% | 28371-401U |
| D10 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D11 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D12 | DI ZEN 1N825/A 6.2V 5% | 28371-494Z |
| D13 | DI ZEN 1N819 6.2V 5% LOW TC * | 28371-530K |
| D14 | DI ZEN BZX79C 5.6V 5% | 28371-417X |
| D15 | DI BRIDGE KBP608 800V 6A | 28359-199B |
| D16 | DI RECT MR810 50V 1A 100NS * | 28355-167U |
| D17 | DI RECT MR810 50V 1A 100NS * | 28355-167U |
| D18 | DI RECT MR810 50V 1A 100NS * | 28355-167U |
| D19 | DI ZEN BZX79C 5.1V 5% | 28371-401U |

| Circuit Reference | Description | Part No. |
|---|---|---|
| D20 | DI ZEN BZX79C4V7 4.7V 5% | 28371-371F |
| D22 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D23 | DI RECT 31DQ03 30V SCHOTTKY | 28355-169N |
| D25 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D26 | DI SIL 1N4148 75 V JUNC | 28336-676J |
| D27 | DI SCR BRY55-3 50V 0.8A * | 28385-711A |
| D28 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D29 | LAMP LED YL4484 3V YELLOW | 28624-116K |
| D30 | DI ZEN BZX79C 5.6V 5% | 28371-417X |
| D31 | DI SCR 2N4441 50V 8A * | 28385-713H |
| D32 | DI RECT 1N4004 400V | 28357-020K |
| D33 | DI RECT 1N4004 400V | 28357-028K |
| D34 | DI RECT 1N4004 400V | 28357-028K |
| D35 | DI RECT 1N4004 400V | 28357-028K |
| D36 | DI RECT 1N4004 400V | 28357-028K |
| D37 | DI SIL 1N4148 75V JUNC | 28336-676J |
| IC1 | ICA AMP OP27GZ ULTRA LOW*NOISE | 28461-368T |
| IC2 | ICA AMP OP27GZ ULTRA LOW*NOISE | 28461-368T |
| IC3 | ICA SW HI3-201-5 QUAD * ! | 28461-934Z |
| IC4 | ICA AMP OP14CP DUAL MATCHED * | 28461-367D |
| IC5 | ICD MONO 4047 AST MULTI BI ! | 28468-307C |
| IC6 | ICD MONO 4047 AST MULTI BI ! | 28468-307C |
| IC7 | ICD MONO 4538 DUAL RETR PREC* ! | 28468-313K |
| IC8 | ICD NAND 4011 QUAD 2INP BI ! | 28466-340R |
| IC9 | ICD FF D 4013 DUAL BI ! | 28462-608A |
| IC10 | ICA SW HI3-201-5 QUAD * ! | 28461-934Z |
| IC11 | ICA AMP TL072CP DUAL FET I/P | TEXAS |
| IC12 | ICA DAC AD7543JN 12BIT MULT* ! | 28461-931B |
| IC13 | ICA AMP TL072CP DUAL FET I/P | 28461-348Z |
| IC14 | ICA SW HI3-201-5 QUAD * ! | 28461-934Z |
| IC15 | ICA AMP TL072CP DUAL FET I/P | 28461-348Z |
| IC16 | ICA SW HI3-201-5 QUAD * ! | 28461-934Z |
| IC17 | ICA COMP LM311N DIL8 | 28461-695U |
| IC18 | AMP TL072CP DUAL FET I/P | 28461-348Z |
| IC19 | ICA DAC AD7543JN 12BIT MULT*! | 28461-931B |
| IC20 | ICA AMP TL072CP DUAL FET I/P | 28461-348Z |
| IC21 | ICA DAC HS3140C-4 14BIT MULT*! | 28461-932K |
| IC22 | ICA AMP OP27GZ ULTRA LOW*NOISE | 28461-368T |
| IC23 | ICA AMP OP27GZ ULTRA LOW*NOISE | 28461-368T |
| IC24 | ICA DAC AD7543JN 12BIT MULT*! | 28461-931B |
| IC25 | ICA AMP TL071CP FET I/P DIL8 | 28461-347A |
| IC26 | ICA VREG 78S40 SMPS CTRL DIL16 | 28461-729E |
| IC27 | ICA VREG+ 7815 15V 1A TO220 | 28461-709S |
| IC28 | ICA VREG- 7915 15V 1A TO220 * | 28461-735N |
| IC29 | ICA VREG UA723C PROG DIL14 | 28461-706F |
| L1 | IND CHOKE S.M.P.S. | 44190-043H |
| L6 | IND CHOKE 1UH 10% MINIATURE | 23642-419V |
| PL1 | CON PCB HDR 50WAY FXD STRT * | 23435-953T |
| PL2 | CON PCB MALE 6WAY FXD FR LOCK* | 23435-871N |
| PL3 | CON PART M/W MALE 2W HOUSG 12A | 23435-538D |
| PL4 | CON PCB MALE 6WAY FXD FR LOCK* | 23435-871N |
| PL5 | CON PCB MALE 8WAY FXD FR LOCK* | 23435-872L |
| PL6 | CON PART M/W FEM 9W HOUSG 9A | 23435-520K |
| PL7 | CON PCB MALE 36 FXD STRAIGHT | 23435-121J |
| R1 | RES MF 47K 1/4W 2% 100PPM | 24773-313H |
| R2 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R3 | RES MF 4K7 1/4W 0.5% 50PPM | 24753-484H |
| R4 | RES MF 56K 1/4W 2% 100PPM | 24773-315U |
| R5 | RES MF 39K 1/4W 2% 100PPM | 24773-311A |
| R6 | RES MF 80K6 1/4W .5% 50PPM | 24753-349U |
| R7 | RES MF 100R 1/4W 2% 100PPM | 24773-249J |
| R8 | RES MF 100R 1/4W 2% 100PPM | 24773-249J |
| R9 | RES MG 10M 1/4W 5% | 24321-885W |
| R10 | RES MF 470R 1/4W 2% 100PPM | 24773-265M |
| R11 | RES WW 150R 1.5W 5% | 25123-054V |
| R12 | RES MF 100K 1/4W 2% 100PPM | 24773-321L |
| R13 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |

| Circuit Reference | Description | Part No. |
|---|---|---|
| R14 | RES MF 24K75 .6W .01% .6PPM * | 24722-006S |
| R15 | RES MF 250R .6W .01% .6PPM * | 24722-001L |
| R16 | RV CERM 5K0 LIN 1/2W 10% | 25748-563F |
| R17 | RES MF 22K 1/4W 2% 100PPM | 24773-305R |
| R18 | RES MF 68K 1/4W 2% 100PPM | 24773-317N |
| R19 | RES MF 33K 1/4W 2% 100PPM | 24773-309Z |
| R20 | RES MF 4K7 1/4W 2% 100PPM | 24773-289W |
| R21 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R22 | RES MF 2K05 1/4W .5% 50PPM | 24753-350H |
| R23 | RES MF 48K7 1/4W .5% 50PPM | 24753-351E |
| R24 | RES MF 22K5 .6W .01% .6PPM * | 24722-005V |
| R25 | RES MF 2K25 .6W .01% .6PPM * | 24722-002J |
| R26 | RES MF 250R .6W .01% .6PPM * | 24722-001L |
| R27 | RES MF 1K0 1/4W 2% 100PPM | 24773-273A |
| R28 | RES MF 1K0 1/4W 2% 100PPM | 24773-273A |
| R29 | RES MF 680R 1/4W 2% 100PPM | 24773-269K |
| R30 | RES MF 1K15 1/4W .5% 50PPM | 24753-352U |
| R31 | RES MF 38K3 1/4W .5% 50PPM | 24753-353Y |
| R32 | RES NET 100K 5% 15DIL | 24681-508P |
| R33 | RES MF 100K 1/4W 2% 100PPM | 24773-321L |
| R34 | RES MF 20K .6W .01% .6PPM * | 24722-004G |
| R35 | RES MF 10K .6W .01% .6PPM * | 24722-003F |
| R36 | RES MF 10K .6W .01% .6PPM * | 24722-003F |
| R37 | RES MF 20K5 1/4W .5% 50PPM | 24753-354N |
| R38 | RES MF 40K2 1/4W .5% 50PPM | 24753-355L |
| R39 | RES MF 20K0 1/4W 0.5% 50PPM | 24753-663N |
| R40 | RES MF 20K0 1/4W 0.5% 50PPM | 24753-663N |
| R41 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R42 | RES MF 20K .6W .01% .6PPM * | 24722-004G |
| R43 | RES MF 22K 1/4W 2% 100PPM | 24773-305R |
| R44 | RES MF 22K 1/4W 2% 100PPM | 24773-305R |
| R45 | RES MF 3K9 1/4W 2% 100PPM | 24773-287V |
| R46 | RES MF 22K 1/4W 2% 100PPM | 24773-305R |
| R47 | RES MF 22K 1/4W 2% 100PPM | 24773-305R |
| R48 | RES MF 3K9 1/4W 2% 100PPM | 24773-287V |
| R49 | RES MF 100R 1/4W 2% 100PPM | 24773-249J |
| R50 | RES MF 100R 1/4W 2% 100PPM | 24773-249J |
| R51 | RES MF 100R 1/4W 2% 100PPM | 24773-249J |
| R52 | RES MF 100R 1/4W 2% 100PPM | 24773-249J |
| R53 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R54 | RES MF 6K8 1/4W 2% 100PPM | 24773-293D |
| R55 | RV CERM 10K LIN .5W 10% HORZ | 25711-641G |
| R56 | RV CERM 50K LIN .5W 10% HORZ | 25711-643S |
| R57 | RV CERM 5K0 LIN .5W 10% HORZ | 25711-640F |
| R58 | RES MF 820K 1/4W 2% 100PPM | 24773-344Z |
| R59 | RES MF 4K7 1/4W 2% 100PPM | 24773-289W |
| R60 | RES MF 4K3 1/4W 2% 100PPM | 24773-288S |
| R61 | RES MF 1K0 1/4W 2% 100PPM | 24773-273A |
| R62 | RES MF 1K05 1/4W .5% 50PPM | 24753-360F |
| R63 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R64 | RES MF 20K 1/4W 2% 100PPM | 24773-304C |
| R65 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R66 | RES MF 3K9 1/4W 2% 100PPM | 24773-287V |
| R67 | RES MF 330R 1/4W 2% 100PPM | 24773-261D |
| R68 | RES MF 20K 1/4W 2% 100PPM | 24773-304C |
| R69 | RES MF 3K92 1/4W 0.5% 50PPM | 24753-567S |
| R70 | RV CERM 200R LIN 1/2W 10% * | 25748-567W |
| R71 | RES MF 4K02 1/4W 0.5% 50PPM | 24753-627Y |
| R72 | RV CERM 10K LIN 1/2W 10% * | 25748-566S |
| R73 | RES NET 100K 5% 15DIL | 24681-508P |
| R74 | RES MF 665R 1/4W .5% 50PPM | 24753-361G |

| Circuit Reference | Description | Part No |
|---|---|---|
| R75 | RES MF 1K0 1/4W 2% 100PPM | 24773-279N |
| R76 | RV CERM 10K LIN 1/2W 10% * | 25748-566S |
| R77 | RES MF 130R 1/4W 2% 100PPM | 24773-252J |
| R78 | RES MF 33K 1/4W 2% 100PPM | 24773-309Z |
| R79 | RES MF 62K 1/4W 2% 100PPM | 24773-316Y |
| R80 | RES MF 33K 1/4W 2% 100PPM | 24773-309Z |
| R81 | RV CERM 10K LIN 1/2W 10% * | 25748-566S |
| R82 | RV CERM 10K LIN 1/2W 10% * | 25748-566S |
| R83 | RES MF 4K7 1/4W 2% 100PPM | 24773-289W |
| R84 | RES MF 0R33 0.4W 5% 300PPM | 24783-001A |
| R85 | RES MF 180R 1/4W 2% 100PPM | 24773-255V |
| R86 | RES MF 3K3 1/4W 2% 100PPM | 24773-285F |
| R87 | RES MF 43K 1/4W 2% 100PPM | 24773-312Z |
| R88 | RV CERM 10K LIN .5W 10% HORZ | 25711-641G |
| R89 | RES MF 470R 1/2W 2% 250PPM | 24573-065J |
| R90 | RES MF 24K 1/4W 2% 100PPM | 24773-306B |
| R91 | RES MF 15R 1/4W 2% 100PPM | 24773-229X |
| R92 | RES MF 1K0 1/4W 2% 100PPM | 24773-273A |
| R93 | RES MF 1K0 1/4W 2% 100PPM | 24773-273A |
| R94 | RES MF 1K5 1/2W 2% 250PPM | 24573-077X |
| R95 | RES MF 330R 1/4W 2% 100PPM | 24773-261D |
| R96 | RES MF 68K 1/4W 2% 100PPM | 24773-317N |
| R97 | RV CERM 10K LIN .5W 10% HORZ | 25711-641G |
| R98 | RES MF 1K5 1/2W 1% 100PPM | 24763-853C |
| R99 | RES MF 18R 1/4W 2% 100PPM | 24773-231P |
| R100 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R101 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R102 | RES MF 180R 1/4W 2% 100PPM | 24773-255V |
| R103 | RES MF 100K 1/4W 2% 100PPM | 24773-321L |
| R104 | RES MF 100K 1/4W 2% 100PPM | 24773-321L |
| R105 | RES MF 0R47 0.4W 5% 300PPM | 24783-002Z |
| R106 | RES MF 0R47 0.4W 5% 300PPM | 24783-002Z |
| R107 | RES MF 100R 1/4W 2% 100PPM | 24773-249J |
| R108 | RES MF 4K7 1/4W 2% 100PPM | 24773-289W |
| R109 | RES MF 1K0 1/4W 2% 100PPM | 24773-273A |
| R110 | RES MF 1K2 1/4W 2% 100PPM | 24773-275H |
| R111 | RES MF 1K0 1/4W 2% 100PPM | 24773-273A |
| R112 | RES MF 9K1 1/4W 2% 100PPM | 24773-296X |
| R113 | RES MF 12K 1/4W 2% 100PPM | 24773-299R |
| R114 | RES MF 820R 1/4W 2% 100PPM | 24773-271B |
| R115 | RV CERM 10K LIN 1/2W 10% * | 25748-566S |
| R116 | RES MF 13K 1/4W 2% 100PPM | 24773-300T |
| R117 | RES MF 5K6 1/4W 2% 100PPM | 24773-291S |
| SK7 | CON JUMP FEM 2 1 ROW | 23435-990X |
| TR1 | TR NSI D44C6 45V 50M - PWR* | 28455-301Y |
| TR2 | TR PSI BC307A 45V 130M - GEN | 28435-227H |
| TR3 | TR NSI BC209C 20V 150M - GEN | 28452-771P |
| TR4 | TR PSI BC307A 45V 130M - GEN | 28435-227H |
| TR5 | TR NSI BC209C 20V 150M - GEN | 28452-771P |
| TR6 | TR NSI BC209C 20V 150M - GEN | 28452-771P |
| TR7 | TR PSI MPSL08 12V 700M - SW | 28431-767E |
| TR8 | TR NSI BC209C 20V 150M - GEN | 28452-771P |
| TR9 | TR NSI 2N2222A 40V 300M - GEN | 28454-802F |
| TR10 | TR NMF IRF 521 60V 8A * | 28459-047P |
| TR11 | TR NSI BC209C 20V 150M - GEN | 28452-771P |
| TR12 | TR PSI BC307A 45V 130M - GEN | 28435-227H |
| TR13 | TR PSI BC307A 45V 130M - GEN | 28435-227H |
| TR14 | TR PSI BC307A 45V 130M - GEN | 28435-227H |
| X23 | S/C ACC H/SINK TO220 17K/W | 28488-465W |
| X25 | S/C ACC KIT TO220 INSUL 0.7K/W | 28488-129M |
| X29 | CON PART M/W PIN NO DETENT PCB | 23435-567V |

| Circuit Reference | Description | Part No. |
|---|---|---|
| | Unit AA02/1-PROCESSOR PCB ASSY. | |
| | When ordering, prefix circuit reference with AA02. | |
| | Complete unit | 06960-011 |
| C1 | CAP PETP 100N 63V 10% RAD MIN | 26582-429F |
| C2 | CAP TANT 2U2 35V 20% BEAD | 26486-214V |
| C3 | CAP PETP 100N 63V 10% RAD MIN | 26582-429F |
| C4 | CAP ELEC 100U 35V 20%+ PCB | 26421-122J |
| C5 | CAP TANT 2U2 35V 20% BEAD | 26486-214V |
| C6 | CAP TANT 10U 35V 20% BEAD | 26486-225C |
| C7 | CAP TANT 47U 6V 20% BEAD | 26486-232A |
| C8 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C9 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C10 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C11 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C12 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C13 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C14 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C15 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C16 | CAP CER 100P 63V 2% PLATE | 26343-477V |
| C17 | CAP TANT 22U 16V 20% BEAD | 26486-230B |
| C18 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C19 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| D1 | DI ZEN BZX79C4V7 4.7V 5% | 28371-371F |
| D2 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D3 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D4 | DI RECT 1N4004 400V | 28357-028K |
| D5 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D6 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D7 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D8 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D9 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D10 | DI SIL 1N3595 150V JUNC | 28337-556N |
| D11 | DI H/CARR 1N5711 | 28349-007E |
| IC1 | ICD MONO 4538 DUAL RETR PREC* ! | 28468-313K |
| IC2 | ICD NAND 4093 QUAD 2INP SCH BI ! | 28469-207J |
| IC3 | ICD MP P8085A-2 8 BIT NMOS ! | 28469-415F |
| IC4 | ICD LATCH 74LS373 OCT 3ST | 28462-410E |
| IC5 | ICD BUFF 74LS245 OCT TXRX | 28469-188B |
| IC6 | ICD FF D 74LS74 DUAL +EDG TR | 28462-611A |
| IC7 | ICD DEC/DMX 74LS138 3-8 | 28465-027F |
| IC8 | ICD PROM ASSY (Type 2764) | 28471-014H |
| IC9 | ICD RAM UPD446D-1 2KX8 250NS * ! | 28469-311L |
| IC10 | ICD NAND 74LS00 QUAD 2INP | 28466-345H |
| IC11 | ICD AND 74LS08 QUAD 2INP | 28466-012L |
| IC12 | ICD MP SUP 8255A-5 PRG PER INT ! | 28467-010T |
| IC13 | ICD MP SUP 8255A-5 PRG PER INT ! | 28467-010T |
| PL1 | CON PCB HDR 50WAY FXD STRT * | 23435-953T |
| PL2 | CON PCB HDR 20WAY FIXD STRT * | 23435-951W |
| PL3 | CON PCB HDR 26WAY FXD STRT * | 23435-952D |
| R1 | RES MF 22K 1/4W 2% 100PPM | 24773-305R |
| R2 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R3 | RES MF 270K 1/4W 2% 100PPM | 24773-331D |
| R4 | RES MF 82K 1/4W 2% 100PPM | 24773-319J |
| R5 | RES MF 27K 1/4W 2% 100PPM | 24773-307K |
| R6 | RES MF 22K 1/4W 2% 100PPM | 24773-305R |
| R7 | RES MF 100K 1/4W 2% 100PPM | 24773-321L |
| R8 | RES MF 100R 1/4W 2% 100PPM | 24773-249J |
| R9 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R10 | RES MF 22K 1/4W 2% 100PPM | 24773-305R |
| R11 | RES MF 22K 1/4W 2% 100PPM | 24773-305R |
| R12 | RES MF 47K 1/4W 2% 100PPM | 24773-313H |
| R13 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R14 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R15 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R16 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R17 | RES MF 6K8 1/4W 2% 100PPM | 24773-293D |
| R18 | RES MF 4K7 1/4W 2% 100PPM | 24773-289W |
| R19 | RES MF 1K0 1/4W 2% 100PPM | 24773-273A |
| R20 | RES MF 4K7 1/4W 2% 100PPM | 24773-289W |
| R21 | RES MF 100K 1/4W 2% 100PPM | 24773-321L |
| R22 | RES MF 33K 1/4W 2% 100PPM | 24773-309Z |
| R23 | RES MF 22K 1/4W 2% 100PPM | 24773-305R |
| S1 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S2 | SW SLIDE 4 x 2W 28V DIL QUAD | 23467-307C |
| TR1 | TR NSI 2N2369 15V 500M - SW | 28452-197H |
| TR2 | TR NSI 2N2369 15V 500M - SW | 28452-197H |
| X10 | S/C ACC SKT DIL28 LOW PROFILE | 28488-045L |
| X11 | S/C ACC PAD TO18,ETC TO .1" GRD | 28488-115L |
| XL1 | XTAL 10M P30P 20R | 28312-047U |
| | Unit AA03 - FRONT PANEL ASSY | |
| | When ordering, prefix circuit reference with AA03. | |
| | Complete unit | 06960-002 |
| D1 | LAMP LED YL4484 3V YELLOW | 28624-116K |
| S1 | SW TOG 2C0 LEVER MAINS | 23462-249Z |
| X1 | DISPLAY LCD CUSTOM HAMLIN | 06960-040/ |
| X21 | MOUNT, LAMP | 37590-247D |
| X35 | EDGE METER 200UA 750R | 06960-034/ |
| | Unit AA04 - REAR PANEL ASSY | |
| | When ordering, prefix circuit reference with AA04. | |
| | Complete unit | 06960-003 |
| PL1 | CON PWR MALE 3 FXD RF FILTER | 23423-150L |
| S1 | SW SLIDE 2C0 PANEL MTG | 23467-161W |
| SK1 | CON RF BNC FEM 50 BKHD INS | 23443-449Y |
| SK2 | CON RF BNC FEM 50 BKHD INS | 23443-449Y |
| SK3 | CON RF BNC FEM 50 BKHD INS | 23443-449Y |
| T1 | TRANSFORMER MAINS | 06960-044/ |
| X21 | H/W FUSE HOLDER PANEL 20X5 | 23416-192R |
| X22 | H/W COVER FOR 23416-192/193 | 23416-198E |
| X23 | CON PART PWR COVER INS PVC BLK | 23423-999Y |

| Circuit Reference | Description | Part No. |
|---|---|---|
| | **Unit AA06 - RIBBON CABLE ASSY 50 WAY** | |
| | When ordering, prefix circuit reference with AA06. | |
| | Complete unit | 06960-005 |
| SK1 | CON IDC FEM 50 FREE P+STR/REL | 23435-848T |
| SK2 | CON IDC FEM 50 FREE P+STR/REL | 23435-848T |
| | **Unit AA07 - RIBBON CABLE ASSY 26 WAY** | |
| | When ordering, prefix circuit reference with AA07. | |
| | Complete unit | 06960-006 |
| SK1 | CON IDC FEM 26 FREE P+STR/REL | 23435-847D |
| SK2 | CON IDC FEM 26 FREE P+STR/REL | 23435-847D |
| | **Unit AA10 - POWER LINK SOCKET ASSY** | |
| | When ordering, prefix circuit reference with AA10. | |
| | Complete unit | 06960-013 |
| X24 | CON PART M/W MALE 9W HOUSG 9A | 23435-539T |
| X25 | CON PART M/W SKT+DIMPLE CRIMP | 23435-591E |
| | **Unit AA11 - GPIB INTERFACE MODULE** (Optional accessory) | |
| | When ordering, prefix circuit reference with AA11. | |
| | Complete unit | 03964-650 |
| SK1 | CON 57 FEM 24 FXD PCB EDG GPIB | 23435-133X |
| | **Unit AB01 - KEYBOARD & DISPLAY PCB ASSY** | |
| | When ordering, prefix circuit reference with AB01. | |
| | Complete unit | 06960-012 |
| C1 | CAP CER 56P 63V 2% PLATE | 26343-474J |
| C2 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| C3 | CAP CER 100N 50V 20% M/LAYER* | 26383-534Y |
| IC1 | ICD DRIV HLCD-0438 LCD SER IN ! | 28467-016B |
| IC2 | ICD DRIV HLCD-0438 LCD SER IN ! | 28467-016B |
| PL1 | CON PCB HDR 26 WAY FXD STRT * | 23435-952D |
| R1 | RES NET 4K7 5% 15DIL | 24681-510T |
| R2 | RES MF 4K7 1/4W 2% 100PPM | 24773-289W |
| S1 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S2 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S3 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S4 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S5 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S6 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S7 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S8 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S9 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S10 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S11 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S12 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S13 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| S14 | SW PUSH 1P1W MOM LIPA D6 | 23465-301P |
| X10 | S/C ACC SKT SIL25 W/WRAP SNAP | 28488-172A |

| Circuit Reference | Description | Part No. |
|---|---|---|
| | **Unit AB04 - CABLE ASSY 6 WAY** | |
| | When ordering, prefix circuit reference with AB04. | |
| | Complete unit | 06960-015 |
| SK1 | CON PART M/W 6 WAY HOUSING POL* | 23435-921T |
| X2 | CON PART MIN CRIMP TERML 4809* | 23435-930B |
| | **Unit AB05 - CABLE ASSY 2 WAY** | |
| | When ordering, prefix circuit reference with AB05. | |
| | Complete unit | 06960-014 |
| SK1 | CON PART M/W FEM 2W HOUSG 12A | 23435-519Z |
| X1 | CON PART M/W SKT+DIMPLE CRIMP | 23435-591E |
| | **Unit AB06 - GPIB PCB ASSY** (Optional accessory) | |
| | When ordering, prefix circuit reference with AB06. | |
| | Complete unit | 03964-301 |
| C1 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C2 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C3 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C4 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C5 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C6 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C7 | CAP CER 10N 25V 20% DISC | 26383-006C |
| C8 | CAP TANT 47U 6V 20% BEAD | 26486-232A |
| IC1 | ICD MP SUP 8291A GPIB TALK/LIS ! | 28467-014C |
| IC2 | ICD BUFF 3448 QUAD GPIBTXRX 3S | 28469-190R |
| IC3 | ICD BUFF 3448 QUAD GPIBTXRX 3S | 28469-190R |
| IC4 | ICD BUFF 3448 QUAD GPIBTXRX 3S | 28469-190R |
| IC5 | ICD BUFF 3448 QUAD GPIBTXRX 3S | 28469-190R |
| IC6 | ICD NAND 74LS00 QUAD 2INP | 28466-345H |
| IC7 | ICD BUFF 74LS365A HEX 3ST | 28469-194Z |
| R1 | RES NET 4K7 2% 7SIP | 24681-608D |
| R7 | RES MF 4K7 1/4W 2% 100PPM | 24773-289W |
| R8 | RES MF 4K7 1/4W 2% 100PPM | 24773-289W |
| | **Unit AB07 - SWITCH PCB ASSY** | |
| | When ordering, prefix circuit reference with AB07. | |
| | Complete unit | 03964-302 |
| S1 | SW ROCKER 2C0 6SW DIL | 23465-897N |
| | **Unit AB08 - CABLE ASSY** | |
| | When ordering, prefix circuit reference with AB08. | |
| | Complete unit | 03964-601 |
| PL1 | CON PCB S/TRANS 20 FXD IDC | 23435-860R |
| SK1 | CON IDC FEM 20 FREE P+STR/RLP | 23435-845S |

| Circuit Reference | Description | Part No. |
|---|---|---|
| | **Unit AC03 - POWER REF CABLE ASSY** | |
| | When ordering, prefix circuit reference with AC03. | |
| | Complete unit | 06950-012 |
| X26 | CON PCB FEM 6W FREE SELF LOCK* | 23435-521A |
| X27 | CON PART M/W 6WAY HOUSING POL* | 23435-921T |
| X28 | CON PART MIN CRIMP TERML 4809* | 23435-930B |
| | **Unit AC04 - POWER REFERENCE ASSY** | |
| | When ordering, prefix circuit reference with AC04. | |
| | Complete unit | 06950-100 |
| C1 | CAP CER 100N 100V 20%+ M/LAYER | 26383-532E |
| C2 | CAP CER 33P 63V 5% PLATE | 26343-471Y |
| C3 | CAP CER 18P 63V 5% PLATE | 26343-468Y |
| C4 | CAP CER 18P 63V 5% PLATE | 26343-468Y |
| C5 | CAP CER 100P 63V 2% PLATE | 26343-477V |
| C6 | CAP CER 1N0 63V 10% PLATE | 26383-585M |
| C7 | CAP CER 100N 100V 20%+ M/LAYER | 26383-532E |
| C8 | CAP CER 1N0 63V 10% PLATE | 26383-585M |
| C9 | CAP CER 100N 100V 20%+ M/LAYER | 26383-532E |
| C10 | CAP CER 18P 63V 5% PLATE | 26343-468Y |
| C11 | CAP VAR PLAS 22P 2P TRIM | 26878-407U |
| C12 | CAP CER 100P 63V 2% PLATE | 26343-477V |
| C13 | CAP CER 1N0 63V 10% PLATE | 26383-585M |
| C14 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C15 | CAP TANT 1U0 35V 20% BEAD | 26486-209F |
| C16 | CAP CER 47N 25V 20% DISC | 26383-017U |
| C17 | CAP CER 100N 100V 20%+ M/LAYER | 26383-532E |
| C18 | CAP CER 100N 100V 20%+ M/LAYER | 26383-532E |
| D1 | DI SIL 1N4148 75V JUNC | 28336-676J |
| D2 | DI H/CARR 1N5711 | 28349-007E |
| D3 | DI H/CARR 1N5711 | 28349-007E |
| D4 | DI SIL 1N4148 75V JUNC | 28336-676J |
| IC1 | ICA AMP Op14CP DUAL MATCHED * | 28461-367D |
| L1 | COIL ASSY | 06950-105/ |
| L2 | IND CHOKE 0,1UH 10% MINIATURE | 23642-418G |
| L3 | IND CHOKE 0,1UH 10% MINIATURE | 23642-418G |
| MP1 | BOX | 06950-104/ |
| PL1 | CON PCB MALE 6W FXD SELF LOCK* | 23435-543P |
| R1 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R2 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R3 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R4 | RES MF 47K 1/4W 2% 100PPM | 24773-313H |
| R5 | RES MF 120K 1/4W 2% 100PPM | 24773-323F |
| R6 | RES MF 47K 1/4W 2% 100PPM | 24773-313H |
| R7 | RES MF 220R 1/4W 2% 100PPM | 24773-257W |
| R8 | RES MF 270R 1/4W 2% 100PPM | 24773-259T |
| R9 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R10 | RES MF 220K 1/4W 2% 100PPM | 24773-329T |
| R11 | RES MF 59R0 1/4W .5% 50PPM | 24753-358G |
| R12 | RES MF 141R 1/4W 0.5% 50PPM | 24753-437P |
| R13 | RES MF 8R6 1/4W 0.5% 50PPM | 24753-407M |

| Circuit Reference | Description | Part No. |
|---|---|---|
| R14 | RES MF 220K 1/4W 2% 100PPM | 24773-329T |
| R15 | RV CERM 5K LIN .3W 10% FLAT | 25748-506P |
| R16 | RES MF 13K3 1/4W .5% 50PPM | 24753-359V |
| R17 | RES MF 10K 1/4W 2% 100PPM | 24773-297M |
| R18 | RES MF 49K9 1/4W 0.5% 50PPM | 24753-346Z |
| R19 | RES MF 49K9 1/4W 0.5% 50PPM | 24753-346Z |
| R20 | RES MF 7K5 1/4W 2% 100PPM | 24773-294T |
| SK1 | CON RF SMB MALE 50 PCB ELBOW | 23444-359Z |
| TR1 | TR NSI BC 208B 20V 150M - GEN | 28452-781A |
| TR2 | TR NSI MPSA13 125M - DAR | 28453-842U |
| TR3 | TR NMF 40673 20V 400M DG | 28459-010V |
| | **Unit AF03 - SENSOR INPUT ASSY** | |
| | When ordering, prefix circuit reference with AF03. | |
| | Complete unit | 06950-016 |
| SK10 | CON CIRC FEM 12 FXD HEX NUT * | 23424-521S |
| | **Unit AF04 - RF CABLE ASSY** | |
| | When ordering, prefix circuit reference with AF04. | |
| | Complete unit | 06950-005 |
| SK1 | CON RF SMB FEM 50 FREE ELBOW | 23444-336L |
| | **Unit AF08 - SENSOR CABLE ASSEMBLY** | |
| | When ordering, prefix circuit reference with AF08. | |
| | Complete unit | 06950-039 |
| PL1 | CON CIRC MALE 12 FREE * | 23423-520Z |
| PL2 | CON CIRC MALE 12 FREE * | 23423-520Z |

## MECHANICAL PARTS

Item numbers refer to **Figure 9-1.**

| *Item no.* | *Description* | *Part no.* |
|---|---|---|
| 1 | Top cover | 35904-009F |
| 2 | Side rail, 1 of 2 | 34900-747N |
| 3 | Flange, 1 of 2 | 37590-221X |
| 4 | Spring washer, 1 of 2 | 31119-045W |
| 5 | Arm, 1 of 2 | 37590-222M |
| 6 | Rear foot, 1 of 2 | 37590-505Z |
| 7 | Cap, 1 of 2 | 37590-219M |
| 8 | Boss, 1 of 2 | 37590-220P |
| 9 | Handle assembly | 41700-239W |
| 10 | Rear frame | 35890-072W |
| 11 | Bottom cover | 35904-010L |
| 12 | Pushbutton set | 06960-041/ |
| 13 | Push cover natural, 1 of 13 | 37590-298U |
| 14 | Keycap, orange | 06960-039/ |
| 15 | Front frame | 35890-083B |
| 16 | Stud, 1 of 4 | 37590-223C |
| 17 | Foot, 1 of 4 | 37590-224R |

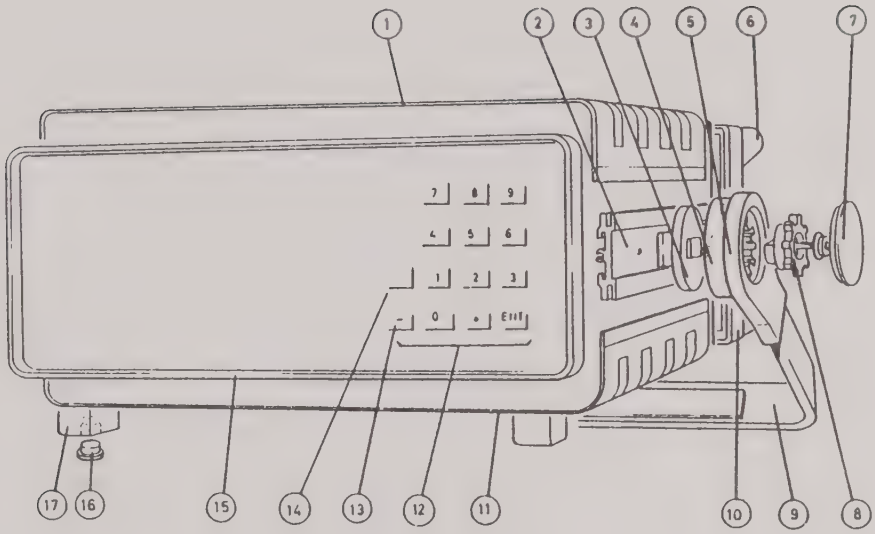



*Figure 9-1. Miscellaneous Mechanical Parts Locations*

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## RF SENSORS FOR THE MODEL 8530 AND 8531 POWER METERS

Contents: Page No.


Introduction....1
RF Sensor General Specifications....1
Sensor Operation - General....2
Sensor Operation with the Model 8530 Meter....2
Sensor Operation with the Model 8531 Meter....3
Low Level Measuring with the 85320 Sensor....4
RF Sensor Electrical Description....4
RF Sensor Maintenance....5
Troubleshooting the 8531X Series Sensors....6
Testing the Chopper Assembly....6
Disassembly of the Sensor....6
Reassembly of the Sensor....7
Troubleshooting the Model 85320 Sensor....8
Sensor Zero Value Check....9
Replaceable Parts Listings....10
Schematic Diagram & Assy. Dwgs - 85310 Sensor..12
Schematic Diagram & Assy. Dwgs - 85312 Sensor..13
Schematic Diagram & Assy. Dwgs - 85313 Sensor..14
Schematic Diagram & Assy. Dwgs - 85319 Sensor..15
Schematic Diagram & Assy. Dwgs - 85320 Sensor..16


### INTRODUCTION

Wavetek has an assortment of five different types of RF power sensors available for use with the Model 8530 and 8531 Power Meters. These sensors offer the user the choice of the various power and frequency ranges in general use to cover the user's specific testing requirements.

The Model 8531X series of sensors are thermocouple units which can be used when testing is to be in the power range of -30 to +20dBm at various discrete frequency ranges, depending on user requirements.

The Model 85320 sensor is a diode unit which covers the -70 to -20dBm power range at frequencies from 10MHz to 20GHz.

The table shown below defines the general specifications for each of the sensors, and the sections to follow will describe the operation, electrical characteristics, and maintenance of the sensors.

### MODEL 8530 AND 8531 POWER METER RF SENSOR GENERAL SPECIFICATIONS

| Model Number | Frequency Range | Power Range | Maximum Power | Linearity Factor Accuracy | Maximum VSWR | RF Connector | Dimensions | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Length | Diameter | Weight |
| 85310 | 10 MHz to 20 GHz | -30 to +20 dBm (1 μW to 100 mW) | +24.8 dBm (300 mW) | ±0.5% at 25°C | 1.25; 10 MHz-30 MHz<br>1.10; 30 MHz-2 GHz<br>1.18; 2 GHz-16 GHz<br>1.28; 16 GHz-18 GHz<br>1.40, typical to 20 GHz | Type N(m) | 87 mm (3.4) in. | 33.5 mm (1.3) in. | 0.14 kg (0.30 lb) |
| 85312 | 30 kHz to 4.2 GHz | −30 to +20 dBm (1 μW to 100 mW) | +24.8 dBm (300 mW) | ±0.5% at 25°C | 1.60; 30 kHz-100 kHz<br>1.20; 100 kHz-300 kHz<br>1.10; 300 kHz-4.2 GHz | Type N(m) | 87 mm (3.4) in. | 33.5 mm (1.3) in. | 0.14 kg (0.30 lb) |
| 85313 | 10 MHz to 26.5 GHz | −30 to +20 dBm (1 μW to 100 mW) | +24.8 dBm (300 mW) | ±0.5% at 25°C | 1.40; 10 MHz-50 MHz<br>1.15; 50 MHz-100 MHz<br>1.10; 100 MHz-2 GHz<br>1.15; 2 GHz-12.4 GHz<br>1.20; 12.4 GHz-18 GHz<br>1.25; 18 GHz-26.5 GHz | APC-3.5(m) | 80 mm (3.2) in. | 33.5 mm (1.3) in. | 0.14 kg (0.30 lb) |
| 85319 | 30 kHz to 3 GHz | −30 to +20 dBm (1 μW to 100 mW) | +24.8 dBm (300 mW) | ±0.5% at 25°C | 1.40; 30 kHz-100 kHz<br>1.15; 100 kHz-300 kHz<br>1.10; 300 kHz-2 GHz<br>1.20; 2 GHz-3 GHz | 75 ohm Type N(m) | 88 mm (3.5) in. | 33.5 mm (1.3) in. | 0.14 kg (0.30 lb) |
| 85320 | 10 MHz to 20 GHz | −70 to −20 dBm (100 pW to 10 μW) | +23 dBm (200 mW) | ±0.5% at 25°C | 1.4 to 1.2;<br>10 MHz-40 MHz<br>1.20; 40 MHz-10 GHz<br>1.35; 10 GHz-18 GHz<br>1.40, typical to 20 GHz | Type N(m) | 104 mm (4.1) in. | 33.5 mm (1.3) in. | 0.18 kg (0.38 lb) |



1499-20040 / 8-87 / 300

## SENSOR OPERATION - GENERAL

The interface and use of each of the five different sensors will follow the same general format with the Model 8531 Power Meter, and a somewhat different format with the Model 8530.

The only physical difference that will be encountered when connecting the sensors to the meters will be when either the 85319 or 85320 sensor is to be used. The 85319 requires a 75 ohm to 50 ohm adapter between the sensor and the Power Reference input on the meters. The 85320 uses a 30dB pad at the Power Reference interface and also requires that, when used with the Model 8530 power meter, a separate magnetic range scale be placed over the instrument's existing Range scale.

The following sections will describe the use of each of the sensors with each instrument.

## SENSOR OPERATION WITH THE MODEL 8530 ANALOG POWER METER

Connect the power sensor to the SENSOR INPUT connection using the sensor cable supplied with the instrument. With no power applied to the sensor, adjust the ZERO control on the most sensitive range (range switch fully counter-clockwise) for a zero reading on the meter.

CAUTION: Before setting up or making measurements, allow time for thermal stabilization. Also, be aware that an unterminated sensor could be effected by RF pickup.

The rear panel RESPONSE TIME potentiometer can be turned fully clockwise to increase the response time. This will reduce the effect of any random noise that may be present which will, in turn, assist in setting the zero. Also, it may be easier to start on a less sensitive range since the ZERO adjustment has a considerable effect.

## CALIBRATION PROCEDURE

1. Initial calibration procedures pertaining to individual sensors will be given in this first step. Steps 2 through 5 pertain to all five sensors.

Model **85310** Sensor

Connect the sensor to the POWER REFERENCE output of the 8530 meter. Set the RANGE switch to 0dBm. Set the CAL FACTOR to 100%. Turn on the POWER REF switch on the rear panel, and adjust the front panel CAL control for a full scale meter reading of 0dBm.

Model **85312** Sensor

Connect the sensor to the POWER REFERENCE output. Set the RANGE switch to 0dBm. Determine the 50MHz REFERENCE CAL FACTOR from the calibration label on the sensor or from the certificate provided with the sensor. Set the CAL FACTOR knob to this figure. Turn on the POWER REF control on the rear panel, and adjust the front panel CAL control for a full scale reading of 0dBm.

Model **85313** Sensor

Connect the sensor to the POWER REFERENCE output of the meter using the Type N to SMC adapter. Set the RANGE switch to 0dBm. Set the CAL FACTOR to 100%. Turn on the POWER REF switch on the rear panel, and adjust the front panel CAL control for a full scale reading of 0dBm.

Model **85319** Sensor

Connect the sensor to the POWER REFERENCE output using the 75 ohm to 50 ohm adapter. Set the RANGE switch to 0dBm. Determine the 50MHz REFERENCE CAL FACTOR at 50 ohms from the calibration label on the sensor or the calibration certificate provided with the sensor. Set the CAL FACTOR knob to this figure. Switch on the POWER REF control on the rear panel, and adjust the front panel CAL control for a full scale meter reading of 0dBm.

Model **85320** Sensor

Connect the sensor, via the specially provided 30dB pad, to the POWER REFERENCE output. Place the magnetic range scale over the

RANGE control shaft, and set the RANGE switch to -30 dBm. Set the CAL FACTOR to the REFERENCE CAL FACTOR indicated on the sensor. Turn on the POWER REF control on the rear panel, and adjust the front panel CAL control for a full scale meter reading of 0dBm.

2. Turn off the POWER REF control.

3. Determine the CAL FACTOR (the 75Ω CAL FACTOR if using the 85319 sensor) for the frequency to be used during the testing routine by referring to the label on the sensor or the calibration certificate that came with the sensor. Set the CAL FACTOR to this value.

4. Disconnect the sensor from the POWER REFERENCE output.

5. The power meter can now be used for measuring RF power. For full instructions and uncertainty calculations, refer to the Model 8530 Power Meter Operating and Maintenance Manual, Section 3, OPERATION.

## SENSOR OPERATION WITH THE MODEL 8531 DIGITAL POWER METER

Connect the sensor to the SENSOR INPUT connection using the sensor cable supplied with the instrument. Determine the linearity factor from the calibration label on the sensor or the calibration certificate that came with the sensor. Enter this figure into the 8531 using the LINEARITY FACTOR function.

CAUTION: Before setting up or making measurments, allow time for thermal stabilization. Also, be aware that an unterminated sensor could be effected by RF pickup.

## CALIBRATION PROCEDURE

1. Initial calibration procedures pertaining to individual sensors will be given in this first step. Steps 2 through 4 pertain to all five sensors.

   Model **85310** Sensor

   Set the CAL FACTOR to 100%. With no power applied to the sensor, press ZERO. When the zeroing is complete (approximately 20 seconds), connect the sensor to the POWER REFERENCE output on the front panel. Press CAL. The instrument will now read 0dBm with the POWER REF pushbutton on the front panel turned on.

   Model **85312** Sensor

   With no power applied to the sensor, press ZERO. After zeroing has completed, connect the sensor to the POWER REFERENCE output on the front panel. Determine the 50MHz REFERENCE CAL FACTOR from the label on the sensor or calibration certificate included with the sensor. Enter this figure into the 8531 using the CAL FACTOR function. Press CAL. The instrument should now read 0dBm with the POWER REF pushbutton on the front panel turned on.

   Model **85313** Sensor

   Set the CAL FACTOR to 100%. With no power applied to the sensor, press ZERO. When zeroing has completed, connect the sensor to the POWER REFERENCE output on the front panel using the Type N to SMA adapter. Press CAL. The instrument will now read 0dBm with the POWER REF pushbutton on the front panel turned on.

   Model **85319** Sensor

   With no power applied to the sensor, press ZERO. When zeroing has completed, connect the sensor to the POWER REFERENCE output on the front panel using the 75Ω to 50Ω adapter. Determine the REFERENCE CAL FACTOR at 50Ω from the label on the sensor or from the calibration certificate included with the sensor. Enter this figure into the 8531 using the CAL FACTOR function. Press CAL. The instrument should read 0dBm with the front panel POWER REF pushbutton on.

   Model **85320** Sensor

   Determine the REFERENCE CAL FACTOR from the label on the sensor or the calibration certificate included with the sensor, and enter

this figure into the 8531 using the CAL FACTOR function. Connect the specially provided 30dB pad to the sensor. With no power applied to the sensor, press ZERO. When zeroing is complete, connect the sensor, via the 30dB pad, to the POWER REFERENCE output on the front panel. Press CAL. The instrument should now read -30dBm with the front panel POWER REF pushbutton turned on.

2. Turn off the POWER REF using the front panel pushbutton, and disconnect the sensor from the POWER REFERENCE output.

3. Determine the CAL FACTOR (the 75Ω Cal Factor in the case of the 85319) for the frequency at which testing will be conducted by again referring to the label on the sensor or the calibration certificate. Enter this figure into the 8531 using the CAL FACTOR function.

4. The 8531 can now be used for measuring RF power. For complete instructions and methods of making uncertainty calculations refer to the Model 8531 Power Meter Operating and Maintenance Manual, Section 3, OPERATION.

## LOW LEVEL POWER MEASUREMENTS WITH THE MODEL 85320 SENSOR

The 85320 RF Power Sensor used with the Model 8530 or 8531 Power Meter is an extremely sensitive measuring system capable of accurately reading power levels as low as 100pW (-70dBm). It is therefore necessary to follow a few simple precautions to ensure an accurate reading at these low levels. These include:

1. Allow the sensor to stabilize to ambient temperature before attempting to start the calibration and measurement procedure.

2. Ensure that the sensor is not subjected to changes in temperature during the calibration and measurement routines. For example, handle the sensor as little as possible and do not try to calibrate or measure in direct sunlight or a stream of hot air being emitted from the cooling fan of an instrument.

3. When zeroing the sensor, be certain that it is not receiving any radiated power at its input connector.

4. During the measurement, the effect of noise can be reduced by either increasing the RESPONSE TIME (rear panel control) on the 8530, or by increasing the AVERAGING FACTOR on the 8531.

## RF SENSOR ELECTRICAL DESCRIPTION

### A. Overall Circuit Description

(Refer to Figure 1)

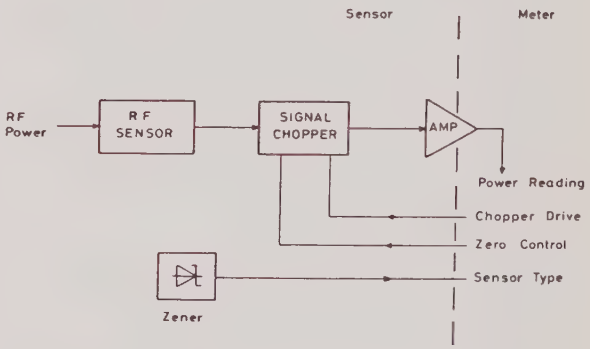



*Figure 1. Block Diagram of RF Power Sensor*

The RF Sensor generates a small dc voltage when power is applied to it. This dc voltage is converted into an ac signal by the Signal Chopper. The chopped signal is fed to the Amplifier which consists of two sections; the first section contained in the power sensor and the second section located in the power meter. The signal is then processed by the power meter to deliver a power reading. A Zener diode in the sensor provides sensor type information for the power meter.

### B. Detailed Description

1. RF Sensors

The 8531X series of sensors use monolithic semiconductor thermocouple components for their power sensing elements. This element provides a good 50Ω match to the RF power, and an output that is proportional to the power be-

ing sensed.

The 85320 sensor uses a low barrier Schottky diode for its power sensing element. The diode will produce an output voltage proportional to the input RF power throughout the sensor's dynamic range.

2. Signal Chopper

The signal chopper consists of two field-effect transistors which act as a sampling gate. The sampling rate is controlled by a 925Hz square wave signal from the power meter. The output of the signal chopper is a 925Hz square wave with amplitude proportional to the RF input power.

A zero control signal from the power meter is introduced at the input of the signal chopper. This allows the power meter to cancel any residual output that occurs with no RF power applied.

3. Amplifier

The amplifier circuitry is contained in both the sensor and the power meter (see Figure 2 for a simplified circuit drawing).

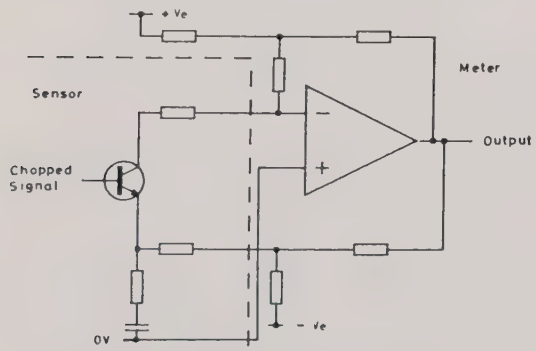



*Figure 2. Simplified Amplifier Circuit*

The amplifier has a gain of approximately 2000, and a band-pass characteristic centered at the sampling rate of 925Hz. For a full description refer to Section 4 of the 8530 or Section 5 of the 8531 Operating and Maintenance Manuals.

A Zener diode is mounted in the sensor to provide head select information for the power meters (tell the meter which type of sensor is attached to it). The 85320 sensor uses a 2.7V diode.

## RF SENSOR MAINTENANCE

### A. TEST EQUIPMENT REQUIRED

| Description | Specification |
|---|---|
| 8530 or 8531 Power Meter | With Sensor Cable |
| Digital Voltmeter | Resolution: 10μV; 1Ω |
| Power Supply | ±5VDC |
| 10K Resistor | |
| Oscilloscope | Bandwidth: >10MHz |
| | Sensitivity: 50mV/DIV |

### B. PRECAUTIONS

To avoid possible damage to the sensor:

1. Exercise extreme care when measuring across or close to the gold wires of the RF assembly. These wires are very delicate and can be easily damaged. All probes must be free of dirt and grease because a dirty probe can impair the performance of the sensor. This is especially true in the vicinity of the gold wires and clamp assembly.

2. Do not connect voltages across any pins not specifically mentioned in these instructions.

NOTE: The high sensitivity of the sensors are such that, unless the RF connector is properly terminated, stray radiation could be detected and displayed on the power meter.

### C. INITIAL TESTING

Connect the sensor to a properly calibrated Model 8530 or 8531 Power Meter using a sensor cable known to be good. Attempt to zero and calibrate the sensor as described in the SENSOR OPERATION section of this publication for the model of power meter being used. Should any failure be encountered, proceed with the troubleshooting instructions given on the following pages.

## TROUBLESHOOTING THE 8531X SERIES SENSORS

(Refer to Figure 3 for the access and layout diagram of the 8531X sensors.

1. Remove the sensor cable from the 12 pin connector on the sensor. Remove the rear plate screws (1) and (2). Remove the rear plate and slide the casing from the sensor.

2. Reconnect the sensor cable and power meter. Connect the input to the 1mW 50MHz Reference Output on the front panel of the power meter (via the 75Ω to 50Ω adapter if testing a Model 85319 sensor). Switch on the POWER REF control on the rear panel, and proceed as follows.

3. Carefully measure the voltage across the gold pads on the FET chopper assembly

4. If the voltage is 100μV or greater, the RF assembly is functioning correctly. Test the chopper assembly as described in the next section.

5. If the voltage is less than 100μV, disconnect the sensor from the POWER REFERENCE output of the power meter.

6. Referring to Figure 3, remove the beam clamp by first loosening the clamp screw (3) and then removing the beam clamp fixing screws (4) and (5). Take out the clamp and carefully lift the gold wires of the RF assembly clear of the gold pads.

7. Reconnect the sensor to the POWER REFERENCE output, be sure it is turned on, and carefully measure the voltage across the gold wires. If this voltage is less than 100μV, the RF assembly is bad and must be replaced.

### TESTING THE CHOPPER ASSEMBLY

1. Disconnect the sensor from the POWER REFERENCE output and remove the sensor cable.

2. Remove the beam clamp as described in Step 6 of the preceding section.

3. Connect a jumper wire between pins B, G, and H of the 12 pin connector to turn both FETs on, and then proceed as follows.

4. Measure the resistance between the two gold pads on the chopper assembly. The resistance should be between 100Ω and 200Ω.

5. Remove the jumpers from pins B, G, and H of the 12 pin connector, and connect the +5V output of the power supply to pin B. Jumper pin G to pin B, and connect the -5V output of the power supply to pin H. This will turn off the parallel FET of the chopper assembly.

6. The resistance measured between the gold pads should now be greater than 10KΩ.

7. Jumper pin H to pin B and apply -5V to pin G. This will turn off the series FET of the chopper. The resistance measured across the gold pads should be greater than 10KΩ.

### DISASSEMBLY OF THE SENSOR

(Refer to Figure 3)

To avoid damaging the internally connected gold wires, disassembly of the sensor must be carried out exactly as given in the sequence that follows.

1. Remove the rear plate screws (1) and (2).

2. Remove the rear plate and slide the casing off of the sensor.

3. Loosen the clamp screw (3), and then remove the beam clamp fixing screws (4) and (5). Carefully remove the beam clamp.

4. Remove the tie rod by loosening screws (6) and (7).

5. Carefully remove the RF assembly fixing screws (8) and (9). Separate the RF assembly from the body assembly, being extremely careful not to damage the gold wires.

6. Remove the PC board fixing screws (10) and (11).

7. Remove the body flange screws (12) and (13). The circuit board and 12 pin connector should now be free.

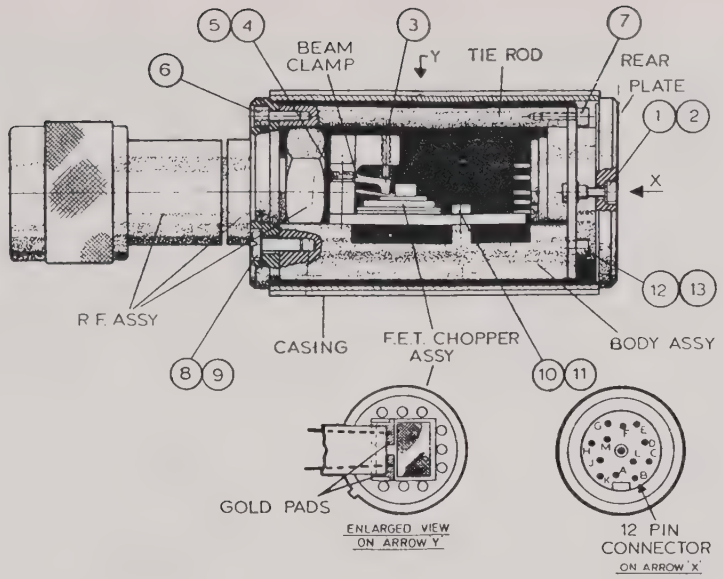



*Figure 3. Series 8531X Sensor Access and Layout Diagram*

REASSEMBLY OF THE SENSOR

1. The circuit board and 12 pin connector are attached to the body of the sensor by replacing the body flange screws (12) and (13), and the circuit board screws (10) and (11).

2. Carefully replace the RF assembly in the sensor body, again taking extreme care not to damage the gold wires. Replace screws (8) and (9).

3. Carefully align the gold wires over the center of the gold pads on the chopper assembly.

4. Ensure that the clamp screw (3) is not in contact with the lower part of the plastic clamp, and fit the beam clamp into position using screws (4) and (5).

5. Tighten the clamp screw (3) to firmly clamp the gold wires. A torque of 2.8 in/oz (2 cNm) is recommended.

6. Connect the partly assembled sensor to the power meter, and check that it is functioning properly using the instructions given in the SENSOR OPERATION section of this publication.

7. Replace the tie rod using screws (6) and (7).

8. Replace the casing and rear plate, inserting and tightening the rear plate screws (1) and (2) to finish the reassembly procedure.

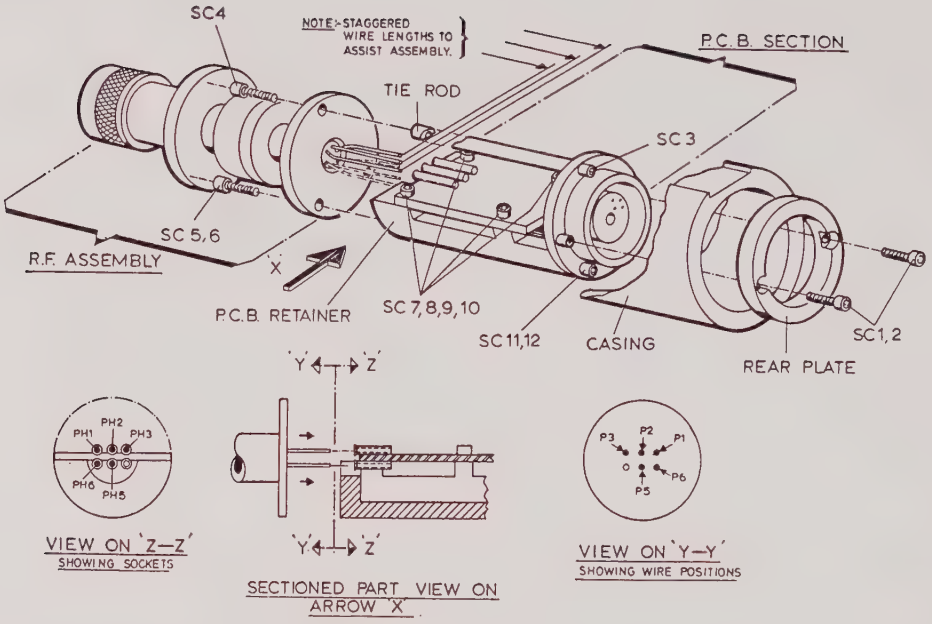



*Figure 4. Model 85320 Sensor Access and Layout Diagram*

## TROUBLESHOOTING THE MODEL 85320 SENSOR

(Refer to Figure 4 for the access and layout diagram to be used when performing the following steps.)

1. Remove the sensor cable from the 12 pin connector on the sensor. Remove the rear plate screws SC1 and SC2. Take off the rear plate and slide the casing from the sensor.

2. Reconnect the cable between the sensor and the power meter. With the oscilloscope, check that the two 925Hz, 0 to -5V square wave chopper drive signals are present on pin receptacles PH5 and PH6 (see view 'Z - Z' in Figure 4) with respect to the chassis.

3. Connect the sensor directly to the POWER REFERENCE output on the front panel of the power meter. Switch on the POWER REF control on the rear panel of the power meter. Using the oscilloscope, carefully measure the voltage waveform between PH2 and the chassis. This should be a 925Hz square wave with a magnitude of about -200mV. If not, it is possible that the RF assembly is bad. This can be checked by following the steps given in the next section.

### TESTING THE RF ASSEMBLY

1. Remove screws SC4, SC5, and SC6. Carefully pull the PC board section away from the RF assembly. Connect the RF assembly directly to the POWER REFERENCE output on the front panel of the power meter.

2. Apply -5V from the dc power supply through the 10KΩ resistor to pin P6 (see the 'Y - Y' view in Figure 4), using the RF assembly chassis as a ground. Connect pin P5 to the chassis. Carefully attach a lead from the DVM LO input to pin P3, and a lead from the DVM HI input to pin P1. Switch the POWER REF control on the rear panel of the power meter on, and check that the reading is greater than -200mV. Reduce the dc power supply to 0V. The DVM reading should decrease to less than -60mV.

3. Switch off the POWER REF control. Apply -5V through the 10KΩ resistor to pin P5, using the

RF assembly chassis as ground. Connect pin P6 to the chassis. Carefully attach a lead from the DVM LO input to pin P3, and a lead from the DVM HI input to pin P2. Switch on the POWER REF control, and check that the reading is greater than -200mV.

4. If the proper results are obtained with Steps 2 and 3, the RF assembly is good. If not, the assembly must be replaced (see the next section).

REPLACING THE RF ASSEMBLY
(Refer to Figure 4)

To disassemble the sensor for RF assembly replacement, perform the following steps.

1. Remove the rear plate screws SC1 and SC2. Remove the rear plate, and slide the casing from the sensor.

2. Remove screws SC4, SC5, and SC6. Carefully pull the RF assembly from the PC board section.

3. To detach the PC board and 12 pin connector from their retainers, remove screws SC7, SC8, SC9, SC10, SC11, and SC12.

To reassemble the sensor, do the following.

1. Attach the PC board and 12 pin connector to their retainers by replacing screws SC7 through SC12. If the tie bar has been removed, it should now be replaced using SC3.

2. Insert the six pins from the RF assembly into the receptacles shown in view 'Z - Z'. The correct orientation of the pins is achieved in two ways:

   a) The longest pair of RF assembly pins, pins P3 and P4, must fit into pin receptacles PH3 and PH4 as shown in Figure 4.

   b) When joining the RF assembly and PC board together, the tapped holes in the retainer and tie rod must correspond with the holes in the RF assembly flange. When the six pins have been carefully inserted, secure with screws SC4, SC5, and SC6.

3. Connect the partially assembled sensor to the power meter, and check that it is functioning properly as described in the SENSOR OPERATION section of this publication.

**SENSOR ZERO VALUE CHECK**

The sensor zero value is the residual output of the sensor when the zero control of the power meter is set to its central value and the RF input is zero. It is very rare that any adjustment is required, but the value should be checked whenever a sensor is reassembled. With the sensor casing and rear plate removed (same condition as Step 3, above), connect the sensor via its cable to the power meter. Be sure it is detached from the POWER REFERENCE output.

ZERO VALUE CHECK USING THE MODEL 8531 POWER METER

Place the meter into the test mode by holding down any key and pressing RESET until the display reads "TEST". Connect the LEVELLING output on the rear of the meter to the DVM. Press the " · " (point) key to set the zero offset. Press key "8" to center the zero offset. The zero value of the sensor, as displayed on the DVM should be within a range of ±200mV. If not, see the SENSOR ZERO ADJUSTMENT section to follow.

ZERO VALUE CHECK USING THE MODEL 8530 POWER METER

Connect the RECORDER OUTPUT on the rear panel of the 8530 to the DVM. Using the magnetic range scale of the 85320 sensor, set the range to -40 dBm. Turn the CAL adjustment on the front panel fully clockwise. Turn the ZERO adjustment fully counter-clockwise. Note the DVM reading. Turn the ZERO adjustment fully clockwise and again note the DVM reading (one reading will be minus and the other reading will be plus). The mean mathematical value of these two readings should be within the range of ±200mV. If not, see the next section.

SENSOR ZERO ADJUSTMENT

Located on the sensor PC board are several insulated wires. The wires that are relevent to the zero adjustment are as follows:

- Two chopper drive wires - one grey and one white.
- One zero wire - violet.

(See the Amplifier PC Board assembly drawing for the sensor of interest, starting on page 12, for the physical location of these wires.)

It is through the correct positioning of these wires that the zero values described in the preceding two sections can be set if they are not already correct.

Moving the violet wire closer to the grey wire should make the zero value more positive, while moving the violet wire closer to the white wire should make the value more negative. These adjustments can be carefully tried while observing the DVM for the results.

After the zero adjustment is completed reassemble the sensor by replacing the casing and rear plate, and then use screws SC1 and SC2 to secure the assembly.

## REPLACEABLE PARTS LISTINGS

This section will show the component reference number, description, and manufacturer's part number for each of the five different sensors. For a description of abbreviations used, reason for differences in component values than those listed, and component ordering information, see Section 8 of the Model 8530 Power Meter Operating and Maintenance Manual or Section 9 of the Model 8531 Power Meter Manual.

### Model **85310** Sensor Parts

| *Circuit Reference* | *Description* | *Manufacturer's Part Number* |
|---|---|---|
| | Power sensor, complete assy. | 6910-001 |
| | N type r.f. assy. replacement kit | 6910-008 |
| | Body assy. (includes Amplifier p.c.b. and Connector assy. SK1) | 6910-002 |
| | Connector assy, SK1 | 6910-052 |
| | Amplifier p.c.b. assy. | 6910-003 |
| C1 | Cer 0.01µF 20% 100V | ITT B111 MZ5U |
| C2 | Tant 4.7µF 20% 50V | STC 39479A |
| C3 | Tant 4.7µF 20% 6.3V | SPRAGUE 499D |
| C4 | Tant 1µF 20% 35V | 26486-209F |
| C5 | Chip 100pF 10% 100V | STC 0805 FX7R |
| C6 | Chip 100pF 10% 100V | STC 0805 FX7R |
| C7 | Tant 2.2µF 20% 50V | STC 42310X |
| D1 | Zener BZX79C5V6 | 28371-417X |
| R1 | RES MF 348kΩ 0.5% 1/8W | HOLCO H8 |
| R2 | RES MO 330Ω 2% 1/8W | CORNING NK3 |
| R3 | RES MO 2.2kΩ 2% 1/8W | CORNING NK3 |
| R4 | RES MO 10kΩ 2% 1/8W | CORNING NK3 |
| R5 | RES WW 100Ω 2% 1/8W | 6910-043 |
| | FET Chopper assy. ⚠ | 6910-004 |
| TR1 | TRANS BC414 | Motorola |

Mechanical parts

| | |
|---|---|
| Beam clamp | 6910-048 |
| Fixing screws (2 off) | 21821-211W |
| Centre fixing screw (1 off) | 21815-359X |
| Casing | 6910-018 |
| Rear plate | 6910-019 |
| Tie rod | 6910-028 |

### Model **85312** Sensor Parts

| *Circuit Reference* | *Description* | *Manufacturer's Part Number* |
|---|---|---|
| | Power sensor, complete assy. | 6912-001 |
| | N type r.f. assy. replacement kit | 6912-008 |
| | Body assy. (includes Amplifier p.c.b. and Connector assy. SK1) | 6912-002 |
| | Connector assy, SK1 | 6912-052 |
| | Amplifier p.c.b. assy. | 6912-003 |
| C1 | Cer 0.01µF 20% 100V | ITT B111 MZ5U |
| C2 | Tant 4.7µF 20% 50V | STC 39479A |
| C3 | Tant 4.7µF 20% 6.3V | SPRAGUE 499D |
| C4 | Tant 1µF 20% 35V | 26486-209F |
| C5 | Chip 100pF 10% 100V | STC 0805 FX7R |
| C6 | Chip 100pF 10% 100V | STC 0805 FX7R |
| C7 | Tant 2.2µF 20% 50V | STC 42310X |
| D1 | Zener BZX796V8 | 28371-550W |
| R1 | RES MF 348k 0.5% 1/8W | HOLCO H8 |
| R2 | RES MO 330 2% 1/8W | CORNING NK3 |
| R3 | RES MO 2.2k 2% 1/8W | CORNING NK3 |
| R4 | RES MO 10k 2% 1/8W | CORNING NK3 |
| R5 | RES WW 100 2% 1/8W | 6910-043 |
| | FET Chopper assy. | 6910-004 |
| TR1 | TRANS BC414 | Motorola |

Mechanical parts

| | |
|---|---|
| Beam clamp | 6910-048 |
| Fixing screws (2 off) | 21821-211W |
| Centre fixing screw (1 off) | 21815-359X |
| Casing | 6910-018 |
| Rear plate | 6910-019 |
| Tie rod | 6910-028 |

## Model **85313** Sensor Parts

| *Circuit Reference* | *Description* | *Manufacturer's Part Number* |
|---|---|---|
| | Power sensor, complete assy. | 6913-001 |
| | 3.5 mm r.f. assy. replacement kit | 6913-008 |
| | Body assy. | 6910-002 |
| | Spare mechanical parts kit | 6910-011 |
| Body assy. (6910-002) | | |
| SK1 | Connector assy. | 6910-052 |
| | Amplifier p.c.b. assy. | 6910-003 |
| C1 | Cer 0.01μF 20% 100V | ITT B111 MZ5U |
| C2 | Tant 4.7μF 20% 50V | STC 39479A |
| C3 | Tant 4.7μF 20% 6.3V | SPRAGUE 499D |
| C4 | Tant 1μF 20% 35V | 26486-209F |
| C5 | Chip 100pF 10% 100V | STC 0805 FX7R |
| C6 | Chip 100pF 10% 100V | STC 0805 FX7R |
| C7 | Tant 2.2μF 20% 50V | STC 52310X |
| D1 | Zener BZX79C5V6 | 28371-417X |
| R1 | RES MF 348kΩ 0.5% 1/8W | HOLCO H8 |
| R2 | RES MO 330Ω 2% 1/8W | CORNING NK3 |
| R3 | RES MO 2.2kΩ 2% 1/8W | CORNING NK3 |
| R4 | RES MO 10kΩ 2% 1/8W | CORNING NK3 |
| R5 | RES WW 100Ω 2% 1/8W | 6910-043 |
| | FET Chopper assy. ⚠ | 6910-004 |
| TR1 | TRANS BC414 | Motorola |

Spare Mechanical Parts kit (6913-011)

| | |
|---|---|
| Beam clamp | 6910-048 |
| Casing | 6910-018 |
| Rear plate | 6910-019 |
| Tie rod | 6910-028 |

## Model **85319** Sensor Parts

| *Circuit Reference* | *Description* | *Manufacturer's Part Number* |
|---|---|---|
| | Power sensor, complete assy. | 6919-001 |
| | N type (75 Ω) assy. replacement kit | 6919-009 |
| | 75 to 50 Ω adapter | 6919-050 |
| | Body assy. (includes Amplifier p.c.b. and Connector assy. SK1) | 6919-002 |
| | Connector assy. SK1 | 6910-052 |
| | Amplifier p.c.b. assy. | 6919-003 |
| C1 | Cer 0.01μF 20% 100V | ITT B111 MZ5U |
| C2 | Tant 3.3μF 20% 50V | STC 61075G |
| C3 | Tant 4.7μF 20% 6.3V | SPRAGUE 499D |
| C4 | Tant 1μF 20% 35V | 26486-209F |
| C5 | Chip 100pF 10% 100V | STC 0805 FX7R |
| C6 | Chip 100pF 10% 100V | STC 0805 FX7R |
| C7 | Tant 2.2μF 20% 50V | STC 42310X |
| D1 | Zener BZX796V8 | 28371-550W |
| R1 | RES MF 523kΩ 0.5% 1/8W | HOLCO H8 |
| R2 | RES MO 330Ω 2% 1/8W | CORNING NK3 |
| R3 | RES MO 2.2kΩ 2% 1/8W | CORNING NK3 |
| R4 | RES MO 10kΩ 2% 1/8W | CORNING NK3 |
| R5 | RES WW 100Ω 2% 1/8W | 6910-043 |
| | FET Chopper assy. | 6910-004 |
| TR1 | TRANS BC414 | Motorola |

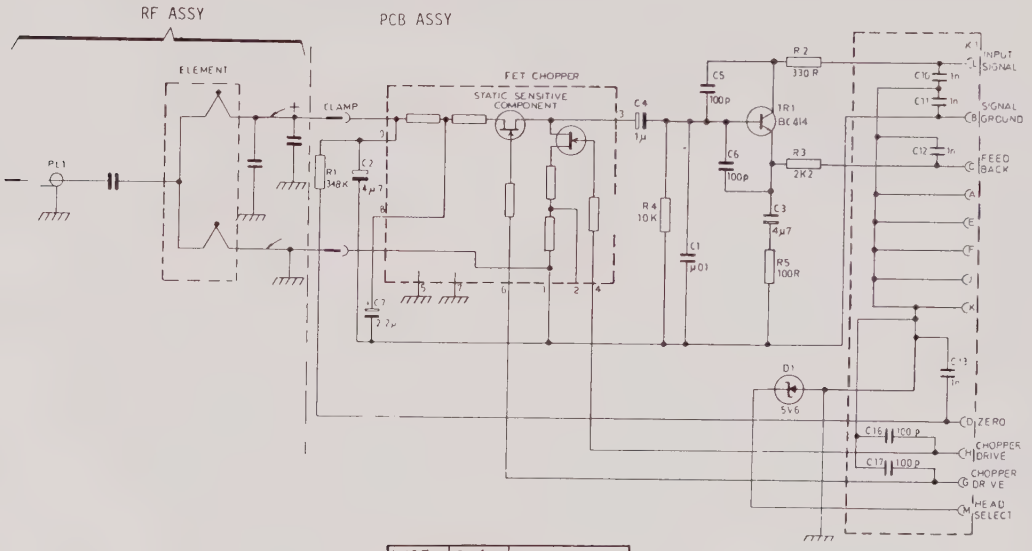
Mechanical parts

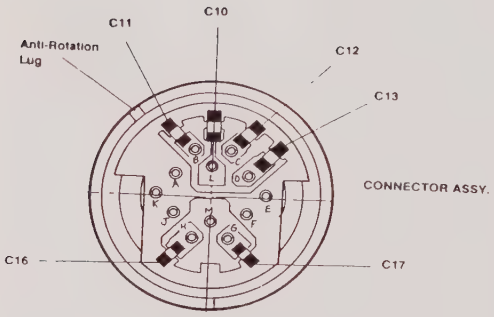
| | |
|---|---|
| Beam clamp | 6910-048 |
| Fixing screws (2 off) | 21821-211W |
| Centre fixing screw (1 off) | 21815-359X |
| Casing | 6910-018 |
| Rear plate | 6910-019 |
| Tie rod | 6910-028 |

## Model **85320** Sensor Parts

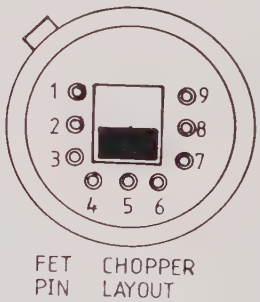
| *Circuit Reference* | *Description* | *Manufacturer's Part Number* |
|---|---|---|
| | Power sensor, complete assy. | 6920-001 |
| | N-type r.f. assy. replacement kit | 6920-040 |
| | Body assy. (incl. amplifier p.c.b. assy. and SK1) | 6920-003 |
| | Tie rod | 6920-011 |
| | Casing | 6920-010 |
| | Rear plate | 6910-019 |
| | Amplifier p.c.b. assy. | 6920-006 |
| C3 | Tant 1μF 20% 35V | 26486-209F |
| C4 | Tant 4.7μF 20% 6.3V | Sprague 499D |
| C5 | Plas 0.1μF 20% 100V | ITT 8111MZ5U |
| C6 | Tant 10μF 20% 6.3V | Sprague 499D<br>Union Carbide<br>STC TAG |
| C7 | Cer 0.047μF 10% 50V | 26343-560M |
| C9 | Tant 0.22μF 20% 35V | 26486-205Y |
| C14 | Chip 100pF 10% 100V | STC 0805FX7R |
| C15 | Chip 100pF 10% 100V | STC 0805FX7R |
| D2 | Zener BZX79C2V7 | 28371-202F |
| R1 | MD 30kΩ 2% 1/8W | Corning NK3 |
| R2 | MF 330Ω 2% 1/8W | Corning NK3 |
| R3 | MF 2kΩ 2% 1/8W | Corning NK3 |
| R4 | MF 10kΩ 2% 1/8W | Corning NK3 |
| R5 | MF 47Ω 2% 1/8W | Corning NK3 |
| R6 | MF 68Ω 2% 1/8W | Corning NK3 |
| TR1 | BC414 | Motorola |
| SK1 | Connector assy. (including C10 to C13, C16 & C17) | 6910-052 |

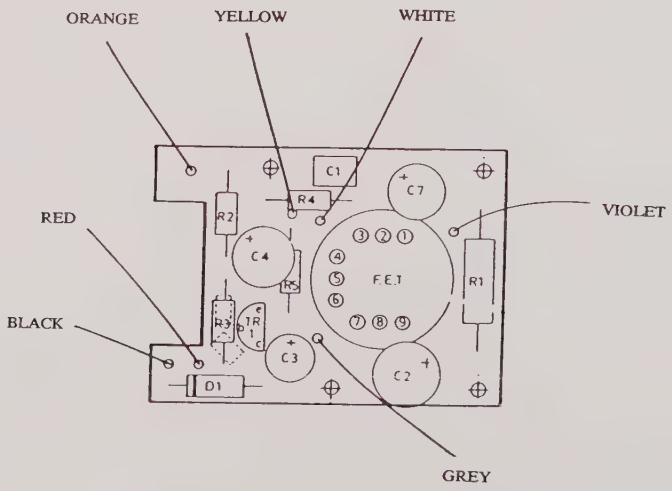
## SCHEMATIC DIAGRAM AND ASSEMBLY DRAWINGS FOR THE MODEL 85310 SENSOR



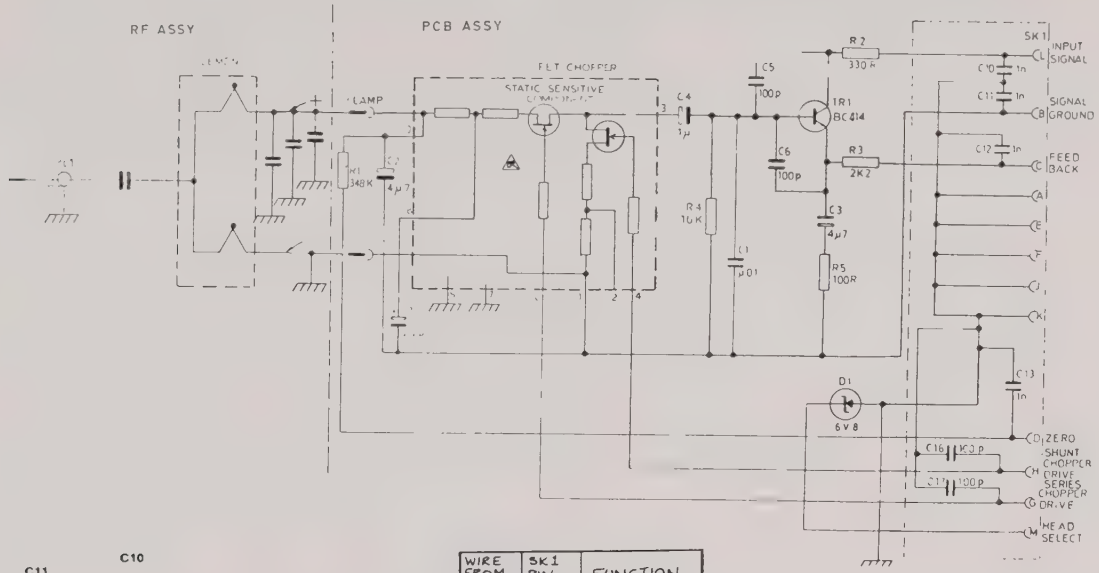

| WIRE FROM P.C.B. | SK1 PIN LETTER | FUNCTION |
|---|---|---|
| | A | |
| YELLOW | B | SIGNAL GROUND |
| RED | C | FEED BACK |
| VIOLET | D | ZERO |
| | E | |
| | F | |
| GREY | H | SERIES CHOPPER DRIVE |
| WHITE | G | SHUNT CHOPPER DRIVE |
| | J | |
| | K | |
| ORANGE | L | INPUT SIGNAL |
| BLACK | M | HEAD SELECT |

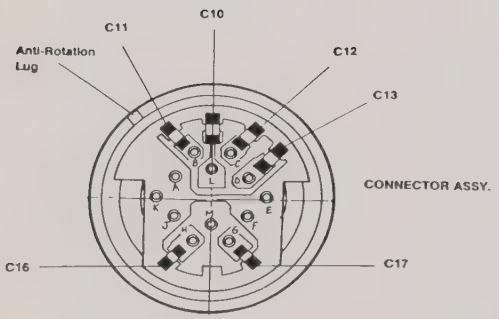


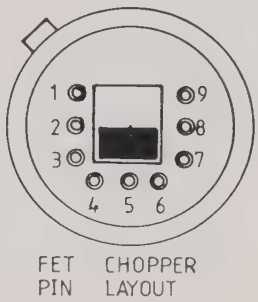

*Model 85310 Sensor Amplifier PC Board Assembly Drawing*

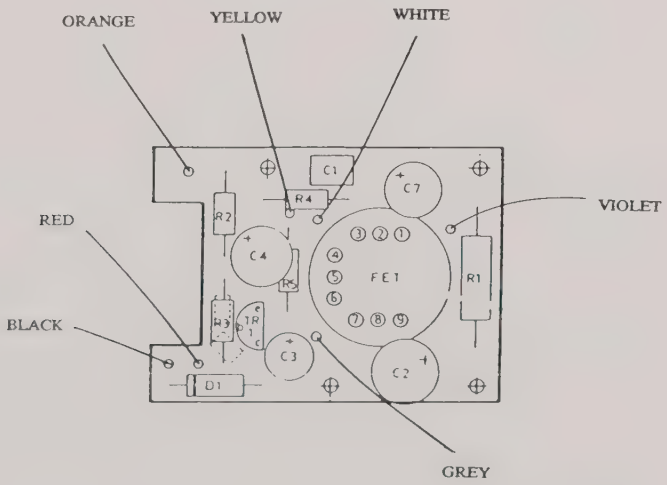
## SCHEMATIC DIAGRAM AND ASSEMBLY DRAWINGS FOR THE MODEL 85312 SENSOR



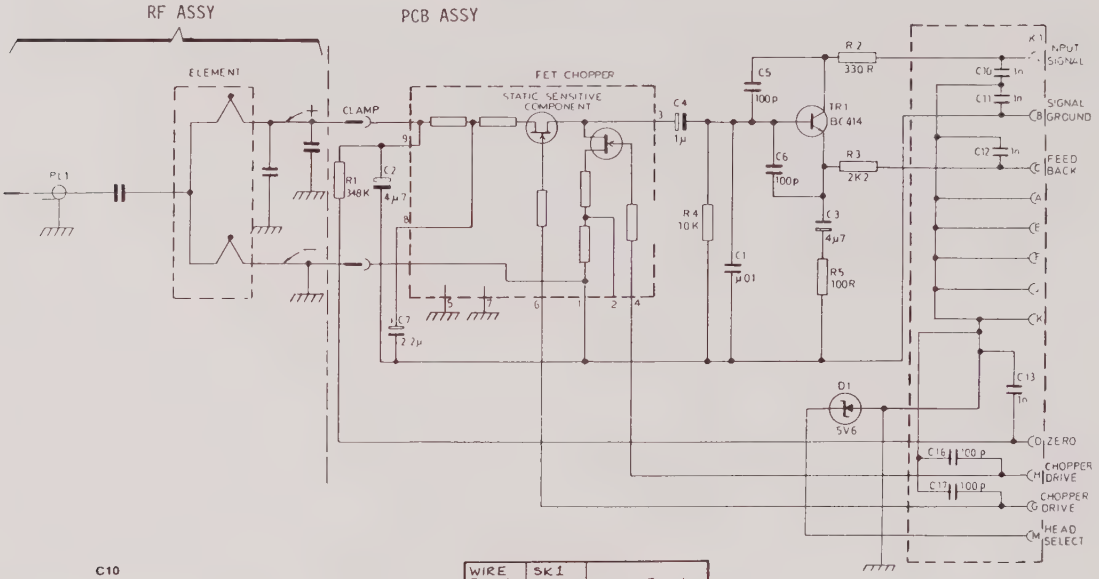

| WIRE FROM P.C.B. | SK1 PIN LETTER | FUNCTION |
|---|---|---|
| | A | |
| YELLOW | B | SIGNAL GROUND |
| RED | C | FEED BACK |
| VIOLET | D | ZERO |
| | E | |
| | F | |
| GREY | H | SERIES CHOPPER DRIVE |
| WHITE | G | SHUNT CHOPPER DRIVE |
| | J | |
| | K | |
| ORANGE | L | INPUT SIGNAL |
| BLACK | M | HEAD SELECT |
| — | — | — |

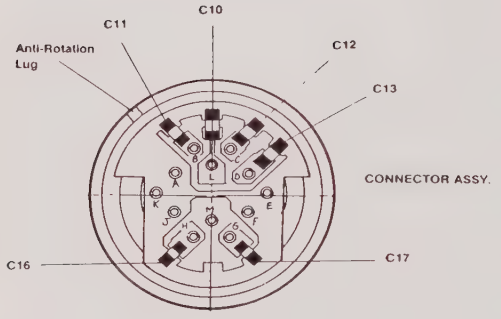


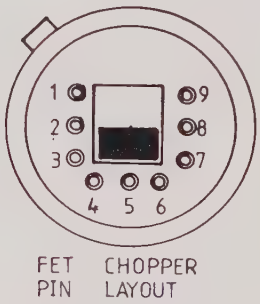

*Model 85312 Sensor Amplifier PC Board Assembly Drawing*

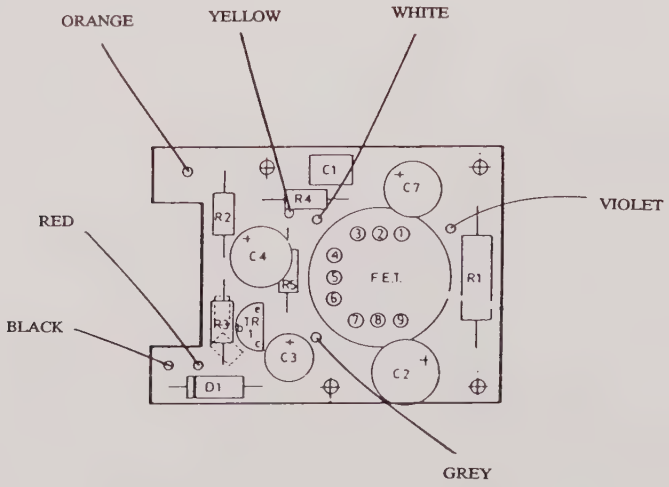
## SCHEMATIC DIAGRAM AND ASSEMBLY DRAWINGS FOR THE MODEL 85313 SENSOR



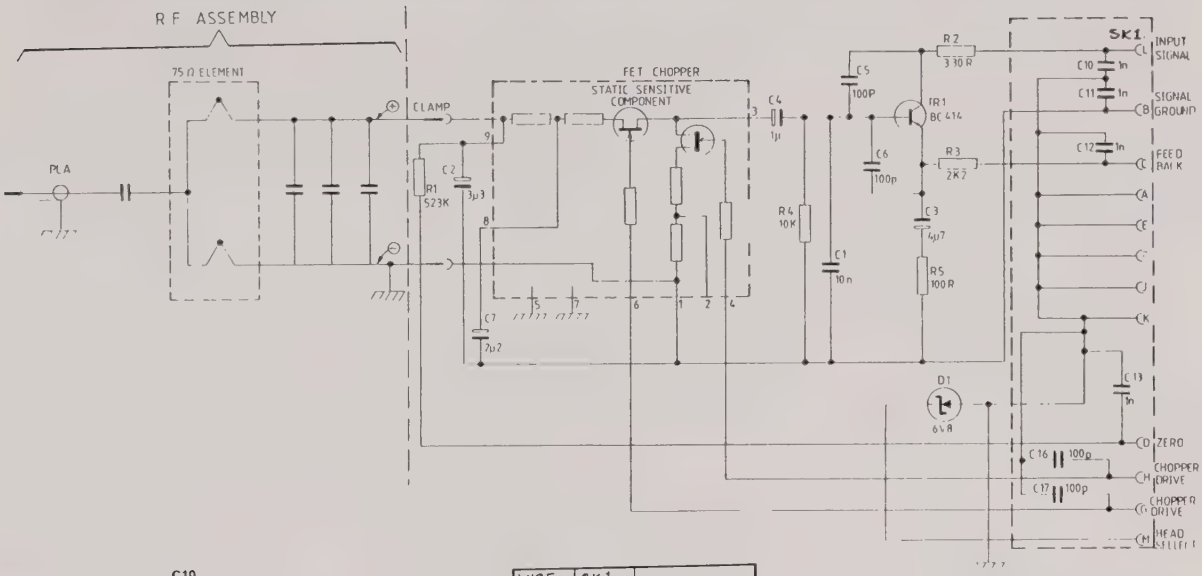

| WIRE FROM P.C.B. | SK1 PIN LETTER | FUNCTION |
|---|---|---|
| | A | |
| YELLOW | B | SIGNAL GROUND |
| RED | C | FEED BACK |
| VIOLET | D | ZERO |
| | E | |
| | F | |
| GREY | H | SERIES CHOPPER DRIVE |
| WHITE | G | SHUNT CHOPPER DRIVE |
| | J | |
| | K | |
| ORANGE | L | INPUT SIGNAL |
| BLACK | M | HEAD SELECT |
| — | — | — |

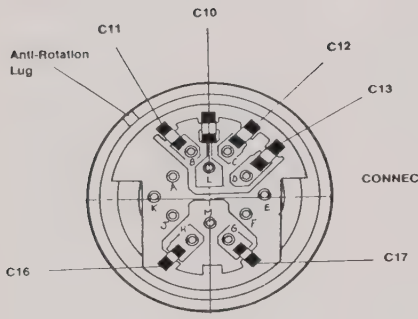


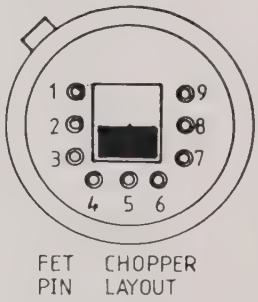

*Model 85313 Sensor Amplifier PC Board Assembly Drawing*

## SCHEMATIC DIAGRAM AND ASSEMBLY DRAWINGS FOR THE MODEL 85319 SENSOR

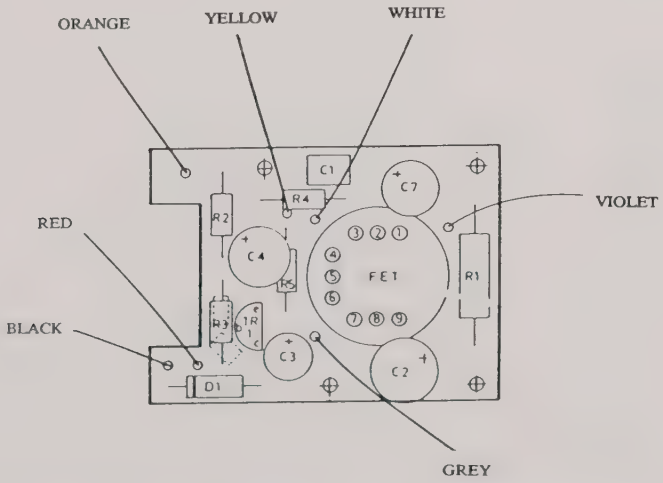



| WIRE FROM P.C.B. | SK1 PIN LETTER | FUNCTION |
|---|---|---|
| | A | |
| YELLOW | B | SIGNAL GROUND |
| RED | C | FEED BACK |
| VIOLET | D | ZERO |
| | E | |
| | F | |
| GREY | H | SERIES CHOPPER DRIVE |
| WHITE | G | SHUNT CHOPPER DRIVE |
| | J | |
| | K | |
| ORANGE | L | INPUT SIGNAL |
| BLACK | M | HEAD SELECT |
| — | — | — |

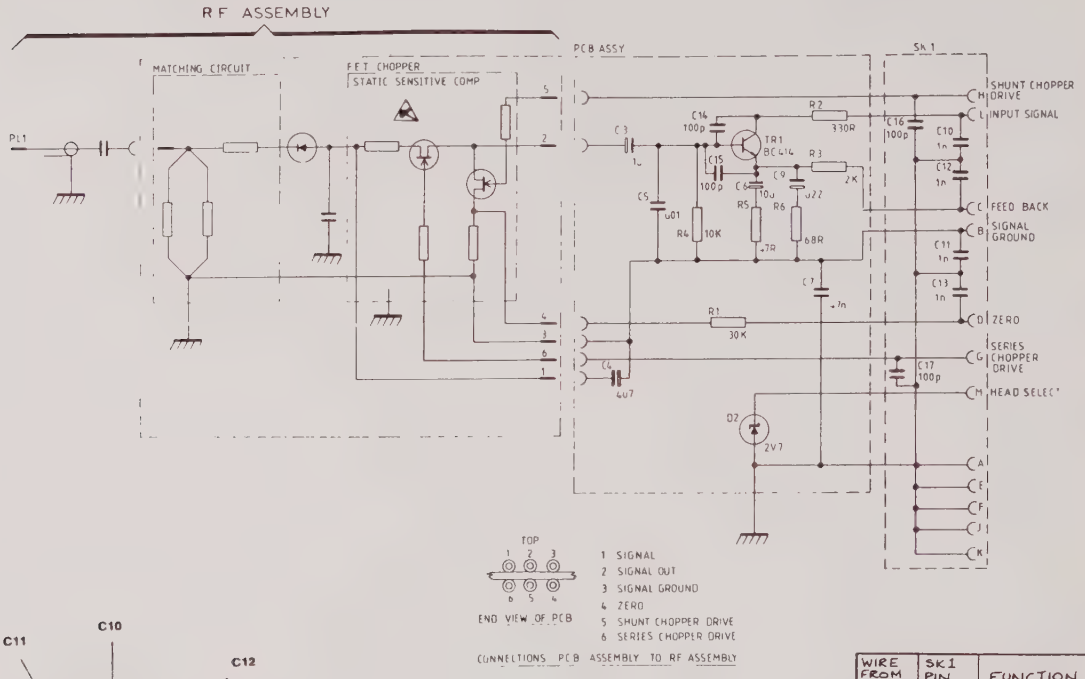


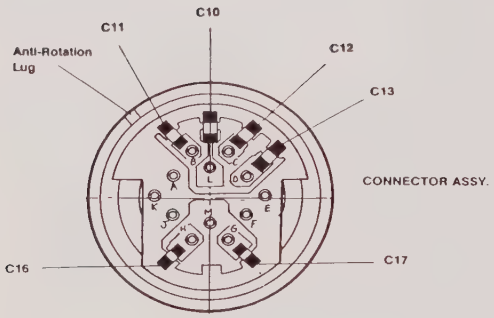

FET CHOPPER PIN LAYOUT



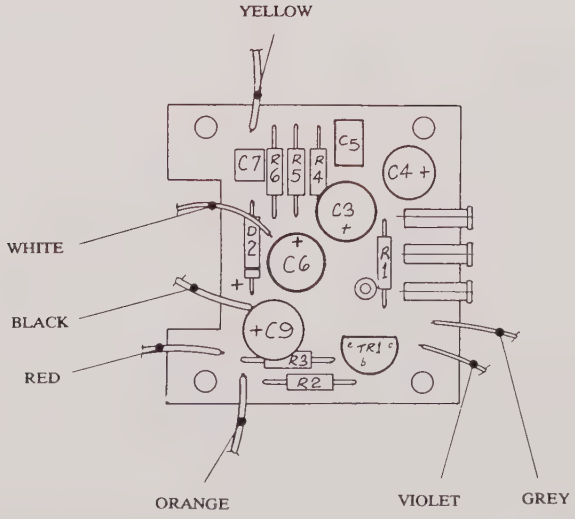

*Model 85319 Sensor Amplifier PC Board Assembly Drawing*

# SCHEMATIC DIAGRAM AND ASSEMBLY DRAWINGS FOR THE MODEL 85320 SENSOR




| WIRE FROM P.C.B. | SK1 PIN LETTER | FUNCTION |
|---|---|---|
| | A | |
| YELLOW | B | SIGNAL GROUND |
| RED | C | FEED BACK |
| VIOLET | D | ZERO |
| | E | |
| | F | |
| GREY | H | SERIES CHOPPER DRIVE |
| WHITE | G | SHUNT CHOPPER DRIVE |
| | J | |
| | K | |
| ORANGE | L | INPUT SIGNAL |
| BLACK | M | HEAD SELECT |
| — | — | — |




*Model 85320 Sensor Amplifier PC Board Assembly Drawing*

# WAVETEK MICROWAVE, INC. MODEL 8531 POWER METER

## GPIB INSTRUCTIONS

### QUICK REFERENCE CARD

(See Section 4 of the Model 8531 Operating and Maintenance Manual for complete description)

### KEYSTROKE MNEMONICS:

| | |
|---|---|
| UNn | Select measurement units (0 = dB; 1 = W) |
| DRm | Enter dB offset |
| STn | Store settings or select PU code |
| RLn | Recall stored settings (0 - 9) |
| SRn | Select range (1 - 5 or " - " for auto.) |
| AVm | Enter averaging factor (1 - 254) |
| LFm | Enter linearity factor (5 - 14.99) |
| DCm | Enter duty cycle (0.001 to 100%) |
| CFm | Enter calibration factor (70 - 100%) |
| PRn | Select power reference (0 = OFF; 1 = ON) |
| AC | Perform AUTOCAL |
| AZ | Perform AUTOZERO |
| RE | Perform instrument RESET |
| E | Floating point entry terminator |

### NON-KEYSTROKE MNEMONICS:

| | |
|---|---|
| TRnn | Select trigger mode |
| RS | Read instrument settings |
| RC | Read instrument calibration data |
| SQn | Set SRQ mode |

Commands can be combined into a string with no individual terminators.

"m" indicates a single character entry which requires no terminator.

"n" indicates a floating point numeric entry requiring the "E" terminator.

### STATUS BYTE ERROR CODES:

| | |
|---|---|
| 01 | Memory checksum failed |
| 02 | No power sensor connected |
| 03 | Autozero failed |
| 04 | Autocal failed |
| 05 | Incorrect data entry |
| 06 | Result greater than 9999 |
| 07 | GPIB command syntax error |
| 08 | GPIB input buffer overflow |
| 09 | GPIB Talk Only error (no listener) |
| 10 | Reading is underrange |
| 11 | Reading is overrange |
| 12 | Recall error (no data in memory) |

### POWER UP (PU) MODES:

Two power up modes are available to define the way the operating parameters will be defined just after the unit is turned on or RESET. The default mode is PU1.

PU1 Selected with "ST-" (dash). Returns instrument settings to default values.

PU2 Selected with "ST." (point). Recalls the most recent instrument settings.

NOTE: RESET can be accomplished either by using the "RE" or the Device Clear (DC) command.

### TRIGGER MODES:

| | |
|---|---|
| TR00 | Normal operation (as LOCAL) |
| TR1n | Free run fast |
| TR20 | Trigger immediate then hold |
| TR3n | Trigger immediate fast then hold |
| TR40 | Free run with settling time |
| TR60 | Trigger immediate with settling time then hold |

"n" indicates averaging factor (0 - 6) applied for "fast" modes. Settling time is defined as the number of display updates equal to the averaging factor in a hold mode, or five times the averaging factor in the free run mode.

### SRQ MODES:

| | |
|---|---|
| SQ0 | Disable all SRQ interrupts |
| SQ1 | Enable SRQ on end of measurement |
| SQ2 | Enable SRQ on error |
| SQ4 | Enable SRQ on end of GPIB operation |

The SRQ mode numbers have binary values and can be applied in any combination by adding the values together.

### SERIAL POLL:

The 8531 responds to a serial poll with a STATUS byte. Each bit of the status byte is defined as follows:

| | |
|---|---|
| 7 | Always zero |
| 6 | 1 indicates SRQ active |
| 5 | 1 indicates SRQ caused by error |
| 4 | Always zero |
| 0-3 | Error number if SRQ on error or 1 indicates SRQ on end of GPIB instruction. 0 indicates SRQ on end of measurement. |

NOTE: No response is given to parallel poll.

### READING CALIBRATION DATA:

The command "RC" tells the 8531 to output an 83 character string in a similar format to "RS" which contains calibration data in exponential format with the following prefixes:

| | |
|---|---|
| AZ | Autozero point |
| AC | Autocal point |
| OA - OE | Offset values for range 1 through 5 |

### READING MEASUREMENTS FROM THE 8531:

When in REMOTE and addressed to talk or in the TALK ONLY mode, the 8531 outputs a string in the following format:

AAAsnnnnEsnnCRLF(EOI)

where: "A" is an alphabetic character
"n" is a numeric digit
"s" is a sign (plus or minus)
"E" is the exponent indicator
"CRLF" is the terminator (EOI with LF)

Characters 1 through 3 contain status information, as follows:

1st Character:

V = valid data
S = waiting for settling time
U = underrange
O = overrange
K = awaiting end of operation

2nd Character:

A through E = ranges 1 through 5

3rd Character:

D = dBm
R = dB relative
W = Watts
O = Watts with offset

In the TALK ONLY mode, data is output only at the end of the free run settling time. EOI is not asserted.

### READING INSTRUMENT SETTINGS:

The command "RS" tells the 8531 to output a 96 character string as follows:

| | |
|---|---|
| UNn | Current units |
| DRsnnnnEsnn | Current dB offset |
| SRn | Current range |
| AVsnnnnEsnn | Current averaging factor |
| LFsnnnnEsnn | Current linearity factor |
| DCsnnnnEsnn | Current duty cycle |
| CFsnnnnEsnn | Current calibration factor |
| PRn | Current status of power reference |
| TRnn | Current trigger mode |
| SQn | Current SRQ mode |
| RFn | Relative measurement flag (0 = OFF; 1 = ON) |
| HFn | Hold flag (0 = AUTO; 1 = Range Held) |
| PUn | Current power up mode |
| ISn | Firmware issue number |

MP MASTER
MA35711